Epidural blood patch in a patient with multiple sclerosis: is it safe?

Le colmatage sanguin péri-dural chez une patiente atteinte de sclérose en plaques: est-ce sécuritaire?

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Abstract

Purpose Multiple sclerosis (MS) is a chronic inflammatory and degenerative disease of the central nervous system resulting in demyelination and axonal injury. Epidural blood patch (EBP) to treat postdural puncture headache (PDPH) in an MS patient may be of concern because of the potential for this to interfere with axonal conduction. Even with normal axons, pressure can interfere with impulse conduction, and it is unknown whether affected axons of the MS patient are particularly vulnerable to the increase in epidural pressure that occurs as a consequence of the EBP. We describe our experience with EBP in an MS patient. While peridural pressure changes were not measured, we attempted to quantify any pressure-induced interference with axonal conduction by measuring changes in somatosensory evoked responses.

Author contributions Vesselina Koeva helped perform the literature review and wrote the initial draft of the manuscript. Amit Bar-Or and Steven Backman helped provide clinical care for the patient. Amit Bar-Or and Daniel Gendron were involved in editing the manuscript. Daniel Gendron helped with interpretation of the electrophysiological data. Steven Backman supervised the project.

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Clinical features A 50-yr-old female MS patient required an EBP for a PDPH after a diagnostic lumbar puncture. The first EBP (20 mL autologous blood, L3–4 interspace) was followed by a transient improvement in PDPH and then a worsening with increased lower-extremity weakness. A second EBP was performed (12 mL autologous blood, L3–L4 interspace) with concomitant evoked potential recordings (stimulating electrodes over the left posterior tibial nerve and recording electrodes at CZ–FZ coordinates). Postdural puncture headache symptoms were permanently relieved, and the effects of the EBP on evoked P40 latency responses (39.7 msec and 44.3 msec pre- and post-EBP, respectively) were considered to be physiologically insignificant.

Conclusion A report of EBP to treat PDPH in an MS patient is presented. We postulate that this type of patient may be at risk for impaired conduction of impulses in affected axons due to the increase in pressure produced by epidural injection of blood. Literature review indicates that pressure increases may be reduced by injecting the blood slowly. When EBP is considered in patients with axon conduction deficits, consideration should be given to concomitant monitoring of somatosensory evoked responses to help quantify interference with axonal conduction as a consequence of injection of blood into the epidural space.

Résumé

Objectif La sclérose en plaques (SP) est une maladie inflammatoire et dégénérative chronique du système nerveux central qui entraîne une démyélinisation et une lésion axonale. Le colmatage sanguin péri-dural (CSP) pour traiter les céphalées post-ponction durale (CPPD) chez un patient atteint de SP pourrait être inquiétant parce qu'il peut entraver la conduction axonale. Même lorsque les axones sont normaux, une pression peut perturber la

conduction d'une impulsion, et nous ne savons pas si les axones affectés d'un patient atteint de SP sont particulièrement vulnérables à l'augmentation de la pression périurale qui survient suite à un CSP. Nous décrivons notre expérience avec un CSP chez une patiente atteinte de SP. Bien que nous n'ayons pas mesuré les changements de pression, nous avons tenté de quantifier toute perturbation de la conduction axonale induite par la pression en mesurant les changements dans les réponses somatosensorielles évoquées.

Éléments cliniques Une femme de 50 ans atteinte de SP a nécessité un CSP pour des CPPD après avoir subi une ponction lombaire diagnostique. Le premier CSP (20 mL de sang autologue, espace intervertébral L3-L4) a été suivi par une amélioration temporaire des CPPD puis par une détérioration accompagnée d'une faiblesse accrue des membres inférieurs. Un deuxième CSP a été réalisé (12 mL de sang autologue, espace intervertébral L3-L4) en enregistrant en même temps les potentiels évoqués (électrodes de stimulation sur le nerf tibial supérieur gauche et électrodes de recueil aux coordonnées CZ-FZ). Les symptômes de céphalées post-ponction durale ont été soulagés de façon permanente, et les effets du CSP sur la latence des réponses évoquées P40 (39,7 msec et 44,3 msec pré- et post-CSP, respectivement) ont été considérées comme non significatives d'un point de vue physiologique.

Conclusion Nous présentons l'utilisation d'un CSP pour traiter des CPPD chez une patiente atteinte de SP. Nous postulons que ce type de patient pourrait courir un risque de conduction altérée des impulsions dans les axones affectés en raison de l'augmentation de la pression produite par l'injection périurale de sang. Une revue de la littérature indique que les augmentations de pression pourraient être réduites en injectant le sang lentement. Lorsqu'on envisage un CSP chez des patients présentant des troubles de la conduction axonale, il faut envisager un monitoring concomitant des réponses somatosensorielles évoquées afin de pouvoir quantifier la perturbation de la conduction axonale découlant de l'injection de sang dans l'espace périurale.

Multiple sclerosis (MS) is a chronic inflammatory and degenerative disease characterized by demyelination and axonal injury in the central nervous system with general sparing of the peripheral nerves.¹⁻³ Cerebral spinal fluid samples obtained by lumbar puncture may be performed to help support the diagnosis of MS.⁴ A well-described complication of lumbar puncture is the postdural puncture headache (PDPH), but the classic treatment of this complication – epidural blood patch (EBP) – may be of

theoretical concern in this unique type of patient. There is extensive literature showing that pressure can interfere with axonal conduction of nervous impulses,⁵⁻⁸ and it is unknown whether affected axons of the MS patient are particularly vulnerable to the increase in epidural pressure that can occur as a consequence of the blood patch. In the one case report we located describing EBP to treat PDPH in an MS patient, concerns with this technique were not addressed.⁹

We describe our experience using EBP to treat PDPH in an MS patient. While peridural pressure changes were not measured, we attempted to quantify any physiological consequences by measuring somatosensory evoked responses immediately prior to and following the blood patch as an indirect measure of interference with axonal conduction of nervous impulses.

Case report

A 50-yr-old female diagnosed with primary progressive MS (as per revised McDonald criteria)¹⁰ developed symptoms consistent with PDPH following a diagnostic lumbar puncture undertaken to exclude other pathologies responsible for the rapid progression of her symptoms. Multiple sclerosis was initially diagnosed ten years previously. The initial symptom was right lower extremity weakness which gradually progressed to right upper extremity weakness and right facial weakness and numbness. During the four months prior to the diagnostic lumbar puncture, mobility became progressively limited due to increasing right-sided weakness. Magnetic resonance imaging indicated C3-4-5, T3, T8 demyelinating lesions without signs of brain involvement. Comorbidities included palpitations associated with a mitral valve prolapse and intermittent nausea and diarrhea. Medications included omeprazole, bisoprolol, prednisone, pancrelipase, zopiclone, lorazepam, acetaminophen, vitamin B₁₂, and vitamin D. Her medical condition was additionally complicated by the possibility of coagulopathy, supported by a history of heavy bleeding after vaginal delivery, total abdominal hysterectomy, and teeth extraction. Although a hematological workup indicated normal clotting factor levels, platelet count, prothrombin time, partial thromboplastin time, and international normalized ratio, a suggestion was raised about possible platelet dysfunction. As such, on the advice of a hematologist, prophylactic administration of 10 U of platelets and 20 U of desmopressin acetate (DDAVP) was carried out prior to the diagnostic lumbar puncture. Under fluoroscopic guidance, a 22G spinal needle was inserted into the L3-L4 interspace and 12 mL of cerebral spinal fluid were collected.

Within 24 hr of the lumbar puncture, the patient experienced severe postdural headache accompanied by tinnitus, neck pain and stiffness, nausea, vomiting, and blurred vision. In addition, the patient experienced new left-sided weakness of the lower extremity. Conservative treatment, including bed rest, encouraged *po* fluid intake, and caffeine, failed, and the situation did not improve by administration of morphine and metoclopramide over a four-week period. At this point, a magnetic resonance imaging of the brain and spinal cord failed to show any changes when compared with the previous study.

The McGill University Health Centre Department of Anesthesia was consulted for treatment of PDPH approximately three weeks after the diagnostic lumbar puncture. Following appropriate history and physical exam, consultation with the patient's neurologist and hematologist, and full disclosure of possible risks, an EBP was performed. As the evidence for platelet dysfunction was equivocal, pre-treatment with platelet transfusion was eschewed; however, 20 units of DDAVP were administered. With the patient in the seated position, 20 mL of autologous blood were slowly injected into the L3-L4 interspace under sterile conditions. The patient was then placed in the supine position on a stretcher for two hours before attempting ambulation. Although symptoms subjectively improved, after 48 hr, the patient complained again of severe orthostatic headache (worse than before the blood patch), stiff muscles, increased left-sided leg weakness, neck pain, and nausea. Following consultation with her neurologist and hematologist, the decision was undertaken to attempt a second EBP with measurement of somatosensory evoked potentials prior to and following the blood patch to help determine whether it interfered with conduction of nervous impulses in the spinal cord. Approximately two weeks after the first EPB, a second procedure was performed after administration of 20 units of DDAVP. To perform the somatosensory evoked potential study (supine position), stimulating electrodes were placed over the left posterior tibial nerve at the ankle, and recording electrodes were placed at CZ-FZ coordinates. Just prior to the EBP, an evoked P40 response at CZ was recorded with a latency of 39.7 msec, although *post hoc* analysis suggested the presence of an overlying 60-Hz artifact (Figure, panel A). With the patient in a seated position, autologous blood (12 mL) was slowly injected into the L3-L4 interspace under sterile conditions until the patient complained of left buttock pain. Somatosensory evoked potentials recorded immediately following the EBP (patient supine) indicated a P40 response with a latency of 44.3 msec (Δ 4.6 msec compared with baseline, Figure, panel B). After the EBP, the patient reported an immediate improvement in symptoms and was permitted to ambulate after a two-hour rest period. This improvement persisted and no further complaints

associated with PDPH were reported. Eight days after the EBP a somatosensory study was repeated and P40 latencies of 43.8 and 47.8 msec were recorded (Figure, panels C and D).

Discussion

We describe successful treatment of a PDPH in an MS patient using the EBP technique, a phenomenon that has been infrequently reported.⁹ This case report is unique in that we used somatosensory evoked responses to help assess possible changes in axonal conduction in the spinal cord associated with the blood patch. The EBP relieved symptoms associated with a PDPH, and we interpret the small increase in evoked P40 response latency as not significant, as detailed below.

Multiple sclerosis is a complex inflammatory and degenerative disease of the central nervous system that results in demyelination, axonal injury, and formation of sclerotic plaques. While the etiology remains unknown, central nervous system injury is largely thought to be immune-mediated. Myelin supports saltatory conduction of action potentials between adjacent nodes of Ranvier of the axon. Disruption of the myelin exposes regions of the axolemma that are largely devoid of sodium channels. This causes action potentials to travel at reduced velocity, and conduction may become partially or completely blocked.¹⁻³

It is well established that conduction of action potentials in healthy axons can be blocked by pressure, and the threshold for this effect is inversely related to the duration of applied pressure. In *in vivo* and *in vitro* animal studies, propagation of evoked compound action potentials may be blocked by pressures as low as 30 mmHg when applied for hours, and much more rapid block is observed with pressures exceeding 200 mmHg. The pathophysiological basis for pressure-induced conduction block is complex, involving physical deformation of the nerve and /or ischemia – anoxia. Myelinated large-diameter fibres are more sensitive to compression *per se* than smaller-diameter fibres, while the former are more resistant to anoxia.⁵⁻⁸ Following injection of fluid with the epidural technique, the resulting pressure changes exerted on the spinal cord may not be appreciated. In human volunteer studies, rapid injection (15 sec) of saline 10-20 mL or local anesthetic into the lumbar epidural space can produce peak increases in epidural and subarachnoid pressures of approximately 48 and 63 mmHg, respectively.^{11,12} On the other hand, slower injection (e.g., autologous blood 2.5 mL injected over 30 sec, 15 mL total) produces a much more modest peak increase in pressure (approx 11 mmHg).¹³ Germane to this case, we were concerned that the increase in epidural pressure associated with the EBP may compromise nervous conduction in the frail components of the central nervous

Figure P40 responses recorded from CZ in response to electrical stimulation of the posterior tibial nerve (3.1 Hz, 0.2 msec, 13–16.5 mA). Each trace is the average of 180–420 responses, with onset of stimulation (time 0) denoted by an initial deflection of the stimulus artifact. Evoked responses were recorded just prior to and following the epidural blood patch (*panels A and B, respectively*), and at eight days following the epidural blood patch (*panels C and D*)

system affected by MS, and we were unaware whether this possibility had yet been considered.

To help obtain an objective measurement of the effect of the EBP on neuronal function, somatosensory evoked responses were recorded immediately preceding and following the procedure. Somatosensory responses may be used to evaluate axonal conduction in MS patients, although there may be poor correlation between changes in evoked responses and clinical progression of the disease, and variability of responses between test sessions in stable patients may be observed.¹⁴ The “middle latency” P40 response to electrical stimulation of the tibial nerve reflects conduction through peripheral nerves, spinal cord, and cortex.^{14,15} With the patient described in this report, all P40 response latencies fell just outside the mean range of published normal values, consistent with the interference of axonal conduction associated with MS.^{15,16} The 4.6 msec latency difference of P40 responses recorded just prior to and following EBP is actually smaller than left- vs right-sided values in MS patients showing unilateral signs and symptoms of their disease.^{15,16} Moreover, eight days following the EBP, the P40 latencies of 47.8 msec and 43.8 msec (Δ 3.5 msec) were recorded during the same session. With these considerations in mind and the well-known variability of responses observed even in stable patients,¹⁴ we consider that the EBP did not significantly

alter evoked somatosensory responses and, by analogy, any increase in epidural pressure had no physiological consequence with respect to axonal conduction. This view is also supported by the clinical observation that resolution of postdural puncture symptoms following the EBP was not accompanied by deterioration in motor or sensory function.

Needling the epidural space in a patient with a pre-existing neurological deficit warrants careful medical and legal considerations, and there is an established literature dealing with risk associated with neuraxial anesthesia for patients with MS.¹⁷ Nevertheless, there is a paucity of literature concerning EBP in this type of patient. In the case described in this report, the situation was particularly complex given the evolving neurological deficit and the possibility of concurrent platelet dysfunction. A multidisciplinary team approach involving the patient’s neurologist, hematologist, and anesthesiologist was essential, as were frank discussions with the patient during which the potential risks and benefits were continuously evaluated. Orchestration of a somatosensory evoked study with the performance of an EBP should not be underestimated, and one or both of these may have to be performed in an unusual environment.

In conclusion, we describe the rare report of successful EBP to treat PDPH in a patient with MS. We draw attention to the potential that this type of patient may be at risk

for impaired conduction of impulses in affected axons due to the increase in pressure produced by epidural injection of blood. Review of the literature suggests that pressure increases may be considerably reduced by injecting the blood (or any other fluid) slowly over a few minutes. When EBP is contemplated in patients with axon conduction deficits, consideration should be given to concomitant monitoring of somatosensory evoked responses.

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No conflicts of interest are declared.

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