Failed spinal anaesthesia: cause identified by MRI

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Purpose: To determine the cause of failed spinal anaesthesia, magnetic resonance images of the lumbar spine were examined.

Clinical futures: A 28-yr-old woman, scheduled for closure of a rectal fistula under spinal anaesthesia, hyperbaric tetracaine 12.5 mg injected into the subarachnoid space at L₃₋₄ repeatedly resulted in restricted sacral spread. Magnetic resonance imaging showed that the cylindrical dimension of the lumbar spinal canal was wider than in normal subjects, suggesting a larger volume of CSF within the dural sac below the termination of the cord. The summit of the lumbar convexity was located at L₃, which was more cephalad than the L₃₋₄ puncture site.

Conclusion: The uncommon anatomical characteristics of the lumbar spinal canal identified by magnetic resonance imaging were considered to be the reason for the restricted sacral spread observed repeatedly in this patient.

Objectif: Déterminer à l'aide de l'imagerie par résonance magnétique (IRM) les causes de l'échec d'une rachianesthésie.

Caractéristiques cliniques: Chez une femme de 28 ans programmée pour une fermeture de fistule rectale sous rachianesthésie, l'injection répétée de 12,5 mg de tétracaïne hyperbare dans l'espace sous-archnoïdien à L₃₋₄ a produit une analgésie limitée à la région sacrée. L'IRM a révélé que la dimension cylindrique du canal rachidien lombaire était plus grande que la normale, suggérant que le sac dural contenait aussi un plus grand volume de LCR. Le sommet de la con-

vexité lombaire était situé à L₃, niveau plus élevé que le site de ponction L₃₋₄.

Conclusion: Les caractéristiques anatomiques inhabituelles du canal rachidien lombaire identifiées par IRM ont été considérées comme la cause de la restriction à la région sacrée de l'analgésie observée à plusieurs reprises chez cette patiente.

Spinal anaesthesia with hyperbaric local anaesthetic is one of the most reliable of anaesthetic techniques in clinical practice. Once hyperbaric local anaesthetics are deposited in the mid-lumbar subarachnoid space, an adequate block is expected. However, failed spinal anaesthesia rarely occurs after an uneventful spinal injection.¹⁻³ We encountered a case in which an uneventful spinal injection repeatedly resulted in restricted sacral spread. Magnetic resonance imaging (MRI) of the lumbar spine showed uncommon anatomical characteristics of the spinal canal, which were considered to be the reason for the restricted sacral spread.

Case report

A 28-yr-old woman was admitted for closure of a rectal fistula. She had suffered from ulcerative colitis since the age of 14 yr. Surgical history included total colectomy with general anaesthesia at the age of 27 yr. She was 159 cm in height and weighed 40 kg.

The patient received premedication with 0.3 mg scopolamine and 50 mg hydroxyzine *im*. After arrival in the operating room, intravenous access was established. She was positioned in the lateral position on a horizontal operating table. Under aseptic condition, a 25 gauge Quincke needle was inserted into the subarachnoid space at the L₃₋₄ interspace. The needle was inserted with its bevel oriented parallel to the dural fibres and then rotated 90° to direct the bevel cephalad. Tetracaine 12.5 mg in 2.5 ml, glucose 10% solution (Tetacaine® for injection 20 mg (crystalline preparation), Kyorin Pharmaceutical Co., Ltd., Tokyo, Japan) was injected through the needle over 25 sec, and the correct position of the needle was confirmed by aspiration and reinjection of clear cerebrospinal fluid (CSF) immediately

Key words

ANAESTHETIC TECHNIQUES: spinal;

MEASUREMENT TECHNIQUES: magnetic resonance imaging.

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before and after the injection. After the subarachnoid injection was performed, the patient was gently turned to the supine position on a horizontal operating table. Because sensory analgesia to pin-prick had reached only L₅, 20 min after the spinal injection, the lumbar puncture was repeated. The same quantity of hyperbaric tetracaine was injected into the subarachnoid space over 25 sec through a 25 gauge Quincke needle inserted at the L₂₋₃ interspace with the patient in the lateral position. The patient was placed on Trendelenburg position for 15 min. Sensory analgesia to pin-prick reached T₄ at 15 min after the second spinal injection. The closure of the rectal fistula took 30 min. Two months later, the patient was scheduled on a closure of a residual rectal fistula under spinal anaesthesia. No premedication was given. She was positioned in the lateral position on a horizontal operating table. Tetracaine 12.5 mg in 2.5 ml, 10% glucose solution was injected over 25 sec through a 25 gauge Quincke needle inserted into the subarachnoid space at the L₃₋₄ interspace in the lateral position on a horizontal operating table. Although deposit of the entire spinal dose in the subarachnoid space was confirmed by aspiration and reinjection of clear CSF immediately before and after the injection, sensory analgesia to pin-prick was L₅ at 20 min after the spinal injection. We decided to repeat lumbar puncture. Tetracaine 10 mg in 2 ml, 10% glucose solution was injected into the subarachnoid space over 20 sec through a 25 gauge Quincke needle at the L₂₋₃ interspace with the patient in the lateral position. Then, the patient was placed in the Trendelenburg position. Sensory analgesia to pin-prick reached T₇ at 15 min after the second spinal injection. The rectal fistula was repaired in 65 min.

MRI findings

To determine the reason for the restricted sacral spread, MRI examination of the lumbar spine was performed on the 7th postoperative day. T₁-weighted sagittal and axial images were obtained by the MRI scanner (MRT-200/FXIII super version, Toshiba Corporation, Tokyo, Japan) operating at 1.5 T with a single surface coil. The area within the dural sac on the axial image at the level of the third lumbar vertebra was 2.8 cm² (Figure C). The highest point of the lumbar spinal canal was found to be located at L₃ (Figure A).

To compare these findings with those in the normal dural sac in young women, MRI examination was also performed in 13 Japanese healthy female volunteers (age 26 ± 4 yr [range 20–31 yr], mean ± SD; height 160 ± 4 cm [range 154–160 cm]; and weight 52 ± 4 kg [range 43–57 kg]). The area within the dural sac on the axial image at the level of the third lumbar vertebra was

1.64 ± 0.33 cm² [range 1.3–2.3 cm²]. The cylindrical dimension of the patient was wider than in controls, suggesting a large volume of CSF within the dural sac.

Discussion

Hyperbaric tetracaine 12.5 mg injected into the subarachnoid space at the L₃₋₄ interspace repeatedly resulted in an unusually low level of block. However, injection of the same dose at the L₂₋₃ interspace led to a successful block. Magnetic resonance imaging (MRI) of the lumbar spine showed uncommon anatomical characteristics of the spinal canal, which consisted of a wider cylindrical dimension and a cephalad positioned summit of the lumbar convexity.

There are several possible causes for restricted spread. Some or all of the anaesthetic solution may not have been introduced into the subarachnoid space. In this case, clear CSF flow was present immediately before and after injection of the anaesthetic solution and, hence, the entire spinal dose seems to have been deposited in the subarachnoid space. There may have been an error with respect to dose and positioning of the patient.³ However, we used 12.5 mg hyperbaric tetracaine with the patient in the lateral position on a horizontal operating table. Usually, 12.5 mg hyperbaric tetracaine 0.5% administered with patients in the lateral position results in a mid-thoracic block.⁴ Tetracaine 12.5 mg is considered to be an adequate dose for a 40 kg, 149 cm adult woman. The local anaesthetic may have been past its expiration date.⁵ However, repeated injection of the same drug led to an adequate block, so that this was not the cause.

The volume of CSF below the termination of the cord may affect the distribution of local anaesthetics within the subarachnoid space. A dose of local anaesthetic injected into an increased volume of spinal CSF may lead to reduced spread of local anaesthetic.⁶ In addition, since hyperbaric anaesthetic solutions injected into the subarachnoid space migrate in both cephalad and caudal directions under the influence of gravity, the anatomical configuration of the lumbar spine in the supine position plays an important role in determining the distribution of anaesthetic. We suggest, in this patient, these two anatomical characteristics of the lumbar spine may have been related to the restricted spread.

In this patient, sagittal and axial MRI of the lumbar spine revealed a very large cylindrical dimension of the spinal canal. The area within the dural sac at the level of the third lumbar vertebra was 2.8 cm². This exceeds values that we found in young female Japanese volunteers (1.64 ± 0.33 cm²). This may result a large volume of CSF below the termination of the spinal cord, and prob-

FIGURE T₁-weighted mid-line sagittal MR images of the lumbar spine in the patient (A) and a healthy female volunteer (age 26 yr, weight 54 kg and 154 cm in height) (B); and T₁-weighted axial MR images at the level of intervertebral foramina of the third lumbar vertebra in the patient (C) and the same volunteer (D). A straight arrow indicates the summit of the lumbar convexity, which is positioned at L₃ in the patient (A) and at L₄ in the volunteer (B). A curved arrow shows the L₃₋₄ interspace, which is located on the down-slope in the caudal direction in the patient (A) and on the down-slope in the cephalic direction in the volunteer (B). The area within the dural sac is larger in the patient (C) than in the volunteer (D), being 2.8 cm² in the former and 1.8 cm² in the latter.

ably led to the restricted sacral spread. However, no studies exist demonstrating variations of size of the normal dural sac determined from MRI. Because the number of the volunteers in the control group was small, our conclusion should be interpreted with caution. In order to advance our understanding of the role of size of the dural sac in failed spinal anaesthetic, large populations including spinal patients with canal stenosis should be studied. Nevertheless, our MRI examination provided a possible explanation for the failed spinal anaesthetic. In addition, in this patient, the summit of the lumbar con-

vexity, that is usually at L₄ in the supine position,⁷ was found to be located at L₃. Thus, the L₃₋₄ interspace was more caudad than the summit of the lumbar convexity (Figure) and this might have increased the amount of hyperbaric tetracaine moving caudally. Lumbar puncture performed at the L₃₋₄ interspace resulted in restricted sacral spread, whereas injection of the same dose at L₂₋₃ led to a successful block.

The incidence of failure to achieve satisfactory spinal anaesthesia varies from 3–14%.¹⁻³ Causes include a lack of free flow of CSF,¹ the use of tetracaine without epi-

nephrene,^{1,3} and errors in judgment with respect to dosage.^{1,3} Of these, failure is most often attributed to technical error.⁸ However, if failed spinal anaesthesia is repeatedly encountered in a same patient, despite following accepted methods, other causes such as anatomical abnormalities of the lumbar spine should be suspected. When such failures occur, maldistribution of the anaesthetic solution within the subarachnoid space may be more common than failure to introduce all or part of the anaesthetic solution into the subarachnoid space. Magnetic resonance imaging of the lumbar spine may assist in determining the exact anatomical characteristics. When the anaesthetic technique needs to be modified, injection at a different site will avoid repetition of the restricted distribution.

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