**THIAMIN** (vitamin B₁) is a water-soluble vitamin involved in glucose metabolism. Its deficiency affects the cardiovascular (wet beriberi) and nervous (dry beriberi) systems, and in industrialized countries, it is commonly linked to chronic alcoholism. Wernicke encephalopathy (WE), a metabolic encephalopathy due to thiamine depletion, is clinically characterized by at least two among four features: nutritional deficit, oculomotor abnormalities, ataxia, and stupor. Laboratory tests (measurement of serum thiamine or erythrocyte transketolase activity) are diagnostic, but the radiologic confirmation can be achieved by magnetic resonance imaging (MRI) with abnormal hyperintense signal in the periaqueductal gray matter, the mamillary bodies, and around the third ventricle on fluid-attenuated inversion recovery and T₂ MRI scans. We report a case of non-alcoholic WE complicating postoperative total parenteral nutrition (TPN) lacking micronutrient supply and confirmed by MRI.

**Case Report**

The diagnosis of benign gastric tumor was established after a gastroscopy with gastric biopsy in a 30-yr-old mother of two children without any relevant medical history but prolonged gastric intolerance and 8 kg weight loss. She underwent an elective laparoscopic partial gastrectomy. On the fourth postoperative day, she had a wound dehiscence and developed peritonitis that required an emergency laparotomy with peritoneal lavage and suture. After this procedure, TPN and adapted antibiotherapy were administered. She developed a digestive tract fistula, and TPN had to be continued. After 30 days, the patient reported fatigue, and hyponatremia (127 mM) and hypophosphatemia developed and were corrected, but she had to be transferred to the intensive care unit for stupor (Glasgow Coma Scale score of 8) without any focal signs, and she was intubated and ventilated. Cerebral computed tomography scan was normal; her sodium concentration went to 150 mM. Micro-nutrients (polyvitamins and trace elements) were added to TPN. After 3 days, her neurologic status improved, allowing extubation, but the clinical examination showed a horizontal nystagmus and a lateral ophthalmoplegia. Laboratory tests (measurement of serum thiamine or erythrocyte transketolase activity) were diagnostic, but the radiologic confirmation can be achieved by magnetic resonance imaging (MRI) with abnormal hyperintense signal in the periaqueductal gray matter, the mamillary bodies, and around the third ventricle on fluid-attenuated inversion recovery and T₂ MRI scans.

**Discussion**

In the Western world, thiamine deficiency is characterized by chronic alcoholism, because it affects thiamine uptake and utilization. However, WE may develop in non-alcoholic conditions, as in prolonged starvation, hyperemesis gravidarum, bariatric surgery, and even healthy infants given the wrong formulas. Thiamine is a cofactor of several enzymes involved in glucose metabolism and cerebral energy utilization, and its depletion could lead to the neuronal damage as seen on MRI, i.e., T₂ and fluid-attenuated inversion recovery hyperintense signaling in the mamillary bodies, periventricular thalami, and periaqueductal gray matter, as well as diffusion-weighted imaging to differentiate vasogenic from cytotoxic edema. Subsequent MRIs may show regres-
In our case, lactic acidosis may occur due to metabolic disturbances. However, it is evocative of thiamine deficiency, especially in children. Our case report emphasizes the diagnostic difficulties leading away from WE in atypical settings. The usefulness of MRI to correct the diagnosis is often masked by other factors. The main issue is to remind us that TPN is not a harmless and easy technique, and that micronutrients should always be administered on a daily basis during TPN.

References


Compression of the Subarachnoid Space by the Engorged Epidural Venous Plexus in Pregnant Women

Tetsuo Takiguchi, M.D., Ph.D.,* Shigeki Yamaguchi, M.D., Ph.D.,* Masatomo Tezuka, M.D., PhD.,† Naoki Furukawa, M.D., Ph.D., † Toshiimitsu Kitajima, M.D., Ph.D.†

Anesthesiology 2006; 105:848–51

IT is well known that the spread of anesthetic level in spinal anesthesia is enlarged in late pregnancy. 1 Physical2,5 and physiologic 4,5 changes in late pregnancy have been suspected as being factors for this mechanism. The engorgement of the epidural venous plexus has been confirmed, and this may compress the subarachnoid space in late pregnancy. However, it remains unclear how the epidural venous plexus becomes engorged. In the current study, to clarify changes in the epidural venous plexus in late pregnancy, we observed the spinal canal using magnetic resonance (MR) images and obtained what we believe to be some valuable information.

Case Report

After obtaining the approval of the hospital ethics committee (Tochigi, Japan) and written informed consent, we studied three pregnant volunteers (aged 25–34 yr; height, 155–162 cm; weight in the pregnant state, 55–62 kg; weight in the nonpregnant state, 47–50 kg). All volunteers were transferred to an MR table and placed in the supine position. T2-weighted midsagittal, axial, and coronal slice images were obtained with the MR imaging system (GE, Fairfield, CT) operating at 1.5 T. A multiecho sequence with a repetition time of 4,500–5,000 ms and an echo time of 96–105 ms was used, with a 256 × 256 or 512 × 256 acquisition matrix. All figures were captured at 37–39 weeks of pregnancy (pregnant state) and 3–10 months after parturition (nonpregnant state) in the same volunteers.

Figure 1 shows axial MR images at each disc level (Th12-L1 to L5-S1) in the pregnant and nonpregnant states, respectively. At each disc level, the engorged veins in the ventral epidural space were observed bilaterally in the pregnant state, but not in the nonpregnant state. The engorged veins narrowed the foramens at each disc level. Figure 2 shows axial MR images at each level of the pedicles (L1-S1) in the pregnant and nonpregnant states, respectively. At each level of the pedicles, the engorged veins crossed at the middle of the vertebra in the pregnant state, but not in the nonpregnant state. All disc levels and levels of the pedicles that we observed, the subarachnoid space was compressed by the engorged venous plexus in the ventral epidural space in the pregnant state.

Compression of the subarachnoid space was more obvious at the lower lumbar spinal levels than at the other levels. Figure 3 shows the intervertebral disc level at L5-S1. Although the subarachnoid space was clearly observed in the nonpregnant state, there was little subarachnoid space in the pregnant state. In the pregnant state, the nerve roots of the cauda equina were compressed and adjacent in the limited subarachnoid space.

Figure 4 shows modified coronal MR images of the spinal canal, captured in the pregnant and nonpregnant states, respectively. In those images, multiple coronal images were computer-processed into one image in alignment with the curvature of the ventral epidural space (Advantage Windows version 2; GE, Milwaukee, WI). The engorged epidural venous plexus in the ventral epidural space was observed between Th12 and S1 in the pregnant state. The engorged

Copyright © by the American Society of Anesthesiologists. Unauthorized reproduction of this article is prohibited.
longitudinal veins were observed bilaterally. The engorged vein crossed at each level of the pedicles, resembling a ladder. However, the engorged veins were not observed in the nonpregnant state. These findings were confirmed in all volunteers.

Discussion

In this study, we presented interesting MR images about the engorgement of the venous plexus in the ventral epidural space in the pregnant state, resulting in narrowing of the foramen and the compression of the subarachnoid space. Those findings were extensively observed and were more obvious at the lower lumbar spinal level than at the other spinal levels. This may promote a better understanding for performing spinal or epidural anesthesia in pregnant patients.

Obstruction of the inferior vena cava by the enlarged pregnant uterus disturbs the return of venous blood from the pelvis and legs to the heart.\(^1\) This affects the blood flow of the collateral circulation, resulting in the engorgement of the venous plexuses in the spinal canal. There has been little information about morphologic changes in the venous plexuses of the spinal canal in the late stage of pregnancy.

Some reports have described changes of the epidural venous plexus in the pregnant state. Igarashi et al.\(^6\) observed the epidural space in pregnant women using epidural fiberoscopy. They showed an increase in the density of the vascular networks and engorgement of vessels in the epidural space. Hirabayashi et al.\(^7\) compared MR images of the spinal canal between nonpregnant and pregnant states, and showed the engorged anterior internal vertebral veins and displacement of the dural sac at 32 weeks’ gestation. However, limited information was revealed in their reports. Therefore, the current study was designed to know more about the morphologic changes in the inside of the spinal canal.

---

**Fig. 1.** Axial magnetic resonance images of the spinal canal at each disc level (Th12–L1 to L5–S1) in the pregnant and nonpregnant states, respectively. To emphasize our point of view, the images at the L2-L3 disc level were enlarged. At the L2-L3 disc level, white arrows indicate the veins in the ventral epidural site. The engorged veins in the ventral epidural space were observed bilaterally in the pregnant state, but not in the nonpregnant state, at each disc level.

**Fig. 2.** Axial magnetic resonance images of the spinal canal at each level of the pedicles (L1–S1) in the pregnant and nonpregnant states, respectively. To emphasize our point of view, the images at the L3 level of the pedicles were enlarged. At the L3 level of the pedicles, white arrows indicate the veins in the ventral epidural site. At each level of the pedicles, the engorged veins cross at the middle of the vertebral level in the pregnant state, but not in the nonpregnant state.
Some interesting findings were obtained from subjects in late pregnancy using MR images, which should be beneficial to understand how to perform spinal or epidural anesthesia in the pregnant state.

In this study, we made four important observations. The first is that the engorgement of the venous plexus was extensively seen. Hirabayashi et al. showed this only between the L2 and L3 levels. We, however, could confirm it from the lower thoracic to sacral levels. The second is that the engorgement of the venous plexus was obvious on the ventral side, but not on the dorsal side. The engorgement of the epidural venous plexus compressed the subarachnoid space. This can explain the mechanism of the spread of anesthetic level in spinal anesthesia for pregnant women. In our previous studies, the compression of the subarachnoid space after epidural injection was confirmed by myelography and MR imaging. However, it was compressed from the dorsal side.

The third observation is a difference in the state of the engorged veins in the epidural space between the disc level and level of the pedicles. In each level of the pedicles, the engorged veins cross at the middle of the vertebral level in the pregnant state. On the other hand, in each disc level, the longitudinal veins were engorged bilaterally in the pregnant state. This may also explain the spread of analgesic level during epidural anesthesia, because of a decrease in the leakage of local anesthetics through the foramen in pregnant women.

The fourth observation is that the compression of the subarachnoid space was more obvious at the lower lumbar spinal levels than at the other levels. It has been thought that the rate of paresthesia during spinal puncture is high in pregnant women. In our MR images, there was only limited subarachnoid space, and the nerve roots of the cauda equina were closely compressed and adjacent at the lower lumbar disc levels.

Furthermore, in the current study, we showed an interesting image, computer-processed into one image in alignment with the curvature of the ventral epidural space from multiple coronal images. This may be useful to understand the morphology of the spinal canal for spinal or epidural anesthesia or both.

Because the number of subjects studied in the current study was limited, we did not measure the area of the subarachnoid space at each level. However, the above findings were observed in all subjects. Our findings can promote a better understanding for performing spinal or epidural anesthesia or both in the pregnant state.

---

**Fig. 3.** Axial magnetic resonance images of the spinal canal at the L5–S1 disc level in the pregnant and nonpregnant states, respectively. In both images, white arrows indicate the subarachnoid space. In the pregnant state, the venous plexus in the ventral epidural space was engorged, resulting in the limited subarachnoid space. The nerve roots of the cauda equina were closely compressed and adjacent in the limited subarachnoid space. On the other hand, the subarachnoid space was clearly observed without the engorged veins in the nonpregnant state.

---

**Fig. 4.** Computerized coronal magnetic resonance images of the spinal canal between T12 and S1 in the pregnant and nonpregnant states. Multiple coronal images are computer-processed into one image in alignment with the curvature of the ventral epidural space. Those images show the curved surface with the ventral epidural space. The engorged epidural venous plexus in the ventral epidural space was observed between Th12 and S1 in the pregnant state, but not in the nonpregnant state. In the pregnant state, arrows indicate the engorged plexus in the ventral epidural space (white arrows = longitudinal veins; dotted arrows = crossed veins). The situation of the engorged epidural venous plexus resembles a ladder.
The authors thank Sumio Washiya, M.D. (President, Washiya Hospital, Utsunomiya, Toshigi, Japan), for generous support.

References