Effects of the pregnant uterus on the extradural venous plexus in the supine and lateral positions, as determined by magnetic resonance imaging

Y. Hirabayashi, R. Shimizu, H. Fukuda, K. Saitoh and T. Igarashi

Summary
To clarify the effects of the pregnant uterus on the extradural venous plexus in the supine and lateral positions, we studied magnetic resonance (MR) images of the lumbar spine in three parturients. T2-weighted axial MR images were obtained with the parturient in the supine and lateral positions. On each slice level in the same subject, the MR images were compared with the control MR images obtained before pregnancy. When the parturient lay supine, the pregnant uterus compressed the inferior vena cava and almost totally obstructed it; the extradural venous plexus was engorged. On turning the parturient into the lateral position, the inferior vena cava was free from compression, and the engorged extradural venous plexus was found to shrink to the level of the non-pregnant state. (Br. J. Anaesth. 1997; 78: 317–319)

Key words

Obstruction of the inferior vena cava by the pregnant uterus in the supine position diverts a proportion of the return of venous blood from the legs and pelvic structures into the vertebral venous system, causing the extradural venous plexus to engorge.1 The lateral positioning of the gravida, however, is expected to resolve the vena caval obstruction.2 Indeed, inferior vena cavogram of the parturient has shown that the lateral position decreases the inferior vena caval obstruction.1 However, it is not clear if the pregnant uterus in the lateral position affects the extradural venous plexus. Our aim was to compare the lateral position with the supine position for the effects of the pregnant uterus on the extradural venous plexus using magnetic resonance (MR) imaging.

Methods and results
The Institutional Review Board approved our study and informed consent was obtained. We studied three female volunteers, aged 29–30 yr. T2-weighted axial MR images of the second and third lumbar vertebrae were obtained using an MR imaging system (MRT-200/FXIII super version, Toshiba Corporation, Tokyo, Japan) operating at 1.5 T. Technical specifications included a repetition time of 3000 ms, an echo time of 112 ms, a slice thickness of 4 mm, number of slices 9 and a field of view of 15 cm. Control (non-pregnant) MR images were obtained before pregnancy with the subject in the supine position. At 32–34 weeks’ gestation, MR images were obtained with the parturient in the supine position (pregnancy-supine) and the left lateral position (pregnancy-lateral). On each slice level in the same subject, we compared the three images (non-pregnant, pregnancy-supine and pregnancy-lateral). The area of the dural sac at the level of the intervertebral disc between the second and third lumbar vertebrae was measured using a digital planimeter (KP-90N, Uchida Yoko, Ltd, Tokyo, Japan).

Representative MR images are shown in figures 1–3 according to the levels of axial slice. With the parturient supine, the inferior vena cava was almost totally obstructed and the extradural venous plexus was engorged significantly (figs 1B, 2B, 3B). Both the medial and lateral components of the anterior internal vertebral veins were found to expand at the level of pedicles (fig. 1B); lateral components were noted to expand at the levels of the lamina and intervertebral disc (figs 2B, 3B). The engorged anterior internal vertebral veins displaced the anterior dural sac posteriorly (fig. 1B). When the parturient turned to the left lateral position, the inferior vena cava was free from compression and the engorged anterior internal vertebral veins were found to shrink in the lateral position (figs 1C, 2C, 3C). The areas of the dural sac at the level of the intervertebral disc between the second and third lumbar vertebrae (non-pregnant, pregnancy-supine and pregnancy lateral) were 2.0, 1.8 and 2.0 cm², respectively, in one subject, 1.5, 1.4 and 1.5 cm² in the second subject, and 1.8, 1.7 and 1.7 cm² in the third subject.

YOSHIHIRO HIRABAYASHI, MD, REIJU SHIMEZU, MD, HIROKAZU FUKUDA, MD, KAZUHIKO SAITOH, MD, TAKASHI I GARASHI, MD, Department of Anaesthesiology, Jichi Medical School, Tochigi, 329-08 Japan. Accepted for publication: October 9, 1996.

Correspondence to Y. H.
The enlarged uterus in the later stages of pregnancy is expected to affect the return of venous blood from the legs and pelvic structures in two ways: first, the pregnant uterus may directly compress the inferior vena cava in the supine position, and second, it may increase intra-abdominal pressure globally. Of these, direct compression on the inferior vena cava may be resolved by lateral positioning of the gravida. In this study, the inferior vena cava was found to be free from compression when the parturient turned to the left lateral position.

In contrast with direct compression on the inferior vena cava, the inferior vena cava was free from compression when the parturient turned to the left lateral position.

**Comment**

The enlarged uterus in the later stages of pregnancy is expected to affect the return of venous blood from the legs and pelvic structures in two ways: first, the pregnant uterus may directly compress the inferior vena cava in the supine position, and second, it may
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vena cava, a global increase in intra-abdominal pressure by the pregnant uterus may affect venous blood flow, regardless of the position. In non-pregnant women, the pressure in the inferior vena cava is normally 4–7 mm Hg in the supine position.\(^3\) This pressure increases to 20–30 mm Hg in late pregnancy. On turning the parturient to the lateral position, the increased pressure was found to decrease rapidly to approximately 10–15 mm Hg.\(^4\) This moderate pressure increase in the inferior vena cava in the lateral position may result from a global increase in intra-abdominal pressure by the enlarged pregnant uterus. In our parturients in the supine position, the anterior internal vertebral veins were found to engorge significantly. This engorgement of the anterior internal vertebral veins may result from diversion of the return of venous blood from the legs and pelvic structures to the vertebral venous system, which is induced by direct compression on the inferior vena cava in the supine position. On turning the parturient to the lateral position, the engorged anterior internal vertebral veins were found to shrink to the level of the non-pregnant state. This suggests that, with respect to the lateral position, the pregnant uterus may not divert the return of venous blood from the legs and pelvic structures to the vertebral venous system. It is unlikely that, in the lateral position, a global and moderate increase in intra-abdominal pressure associated with the pregnant uterus alone causes the extradural veins to engorge. The enlarged uterus during the later stages of pregnancy may cause the extradural venous plexus to engorge mostly by direct compression on the inferior vena cava rather than a global and moderate increase in intra-abdominal pressure.

Recently, Hogan and colleagues\(^5\) investigated the effects of abdominal compression on CSF volume using MR imaging. The authors reported that abdominal compression decreased CSF volume, and that the mechanism by which increased abdominal pressure decreases CSF volume is probably inward movement of soft tissue in the intervertebral foramen, which displaces CSF. Unlike their study, we failed to demonstrate inward movement of soft tissue in the intervertebral foramen, while the engorged extradural venous plexus displaced the dural sac. Our findings are not directly comparable with theirs because both subjects and methods differed between the two studies. In addition, it is likely that the mechanism by which CSF volume is decreased in the parturient may differ from that in brief abdominal compression.

Although we showed that the inferior vena cava became free from compression and the engorged anterior internal vertebral veins shrank during the lateral position, the number of subjects studied was so small that the findings cannot be simply applied to the population as a whole. The availability of pre-pregnant controls, however, provided persuasive findings on the influence of the supine and lateral positions in determining extradural compliance and the volume of the dural sac at the level of the lumbar spine. It would be necessary to study a substantially larger population to confirm these findings and their relation to the spread of regional anaesthesia.

References