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Serum concentration of lidocaine after transversus abdominis plane block

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Abstract
We measured the serum concentration of lidocaine after transversus abdominis plane (TAP) block with 40 ml of 1% lidocaine in 12 patients under general anesthesia, using a fluorescence polarization immunoassay. The peak mean serum concentration of lidocaine occurred 30 min after the block ($3.6 \pm 0.7\ \mu g \cdot ml^{-1}$). The highest concentration of lidocaine ($5.5\ \mu g \cdot ml^{-1}$) was recorded 15 min after the block. These results indicate that a TAP block can potentially cause systemic toxicity of a local anesthetic. The analgesic effect of the TAP block may partially depend on the rise in serum concentration of the local anesthetic.

Key words Transversus abdominis plane block · Lidocaine · Serum concentration

Transversus abdominis plane (TAP) block has been reported to be effective for postoperative analgesia in patients undergoing surgery involving midline abdominal wall incision [1]. In addition, TAP block provides effective analgesia in patients undergoing radical prostatectomy [2] and in patients undergoing cesarean section [3]. Recently, not only a blind but also an ultrasound-guided technique has been reported [4,5]. As large doses of local anesthetics are needed in a TAP block, the risk of systemic toxicity of the local anesthetic, as a result of absorption into the circulation, should always be considered. However, the serum concentration of local anesthetics after a TAP block has never been reported. The objective of this study was to investigate the serum concentration of lidocaine after a TAP block.

After we had obtained institutional approval and written informed consent, 12 patients (American Society of Anesthesiologists physical status I-II) undergoing gynecological laparoscopic surgery under general anesthesia supplemented with a TAP block were enrolled in this study. Exclusion criteria were as follows: liver dysfunction, age more than 70 years, and use of antiarrhythmic medications. No premedication was given. General anesthesia was induced and maintained with propofol (target controlled infusion at $2.5–3.5\ \mu g \cdot ml^{-1}$), remifentanil ($0.1–0.25\ \mu g \cdot kg^{-1} \cdot min^{-1}$), and vecuronium. After tracheal intubation, ultrasound-guided bilateral TAP block was performed following the method reported previously [4], with 20 ml of 1% plain lidocaine on each side. Subsequently, 2-ml venous blood samples were obtained at 1, 5, 15, 30, 60, and 120 min after the block. Then the serum concentration of lidocaine was determined using a fluorescence polarization immunoassay (COBAS INTEGRA 800; Roche Diagnostics, Barcelona, Spain) [6]. Continuous infusion of fentanyl ($0.6\ \mu g \cdot kg^{-1} \cdot h^{-1}$) for postoperative analgesia was started 1 h after the skin incision. After the patient's emergence from general anesthesia, hypesthesia in the abdominal wall was assessed by the loss of sensation to pinprick stimulus. Pain severity at the surgical site was evaluated by an 11-point numeric rating scale (NRS; 0, no pain; 10, worst pain imaginable).

The demographic data of patients and postoperative NRS are shown in Table 1. The serum concentration of lidocaine after the block is demonstrated in Fig 1. The peak mean serum concentration of lidocaine occurred 30 min after the block ($3.6 \pm 0.7\ \mu g \cdot ml^{-1}$). The individual peak serum concentration (Cmax) in all patients ranged between 2.7 and $5.5\ \mu g \cdot ml^{-1}$. In all patients Cmax was achieved 15–60 min after the block. The highest serum concentration of lidocaine ($5.5\ \mu g \cdot ml^{-1}$) was recorded 15 min after the block. Seven of the 12 patients reported decreased perception of pinprick sensation in the lower abdominal wall after their emergence from anesthesia.

This is the first study that has investigated the serum concentration of local anesthetics after a TAP block.

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We found a significant rise in the serum concentration of lidocaine after the TAP block. The highest concentration of lidocaine recorded in this study was 5.5 $\mu g \cdot ml^{-1}$, which was just above the therapeutic range for the antiarrhythmic effect of lidocaine (2–5 $\mu g \cdot ml^{-1}$) and high enough to produce an adverse effect of lidocaine [7]. Although no adverse effect was found in the present study, we suggest that the 400-mg dose of lidocaine for a TAP block should be decreased, especially when using a TAP block in combination with other local anesthesia techniques.

McDonnell et al. [1] used 3 $mg \cdot kg^{-1}$ ropivacaine for a TAP block. We determined the dose of lidocaine based on the assumption that the potency of ropivacaine is 2.5–3 times greater than that of lidocaine [8]. Although the recommendation for the maximum dose of lidocaine is 200 mg, this recommendation is neither evidence-based nor takes the site of injection into account [9]. Previously, Covino and Vassallo [10] reported that 400 mg of lidocaine administered epidurally resulted in about 4 $\mu g \cdot ml^{-1}$ of lidocaine in the blood. The present study showed that the serum concentration of this local anesthetic after a TAP block was comparable to that after an epidural block. When we injected lidocaine under ultrasound guidance, it was found that lidocaine sometimes spilled over into adjacent muscles. The rapid increase in serum concentration of lidocaine found in our study may have been caused by the absorption of lidocaine into the muscle.

Table 1. Demographic data and postoperative pain

Age (years)	44 ± 11
Height (cm)	158 ± 7
Body weight (kg)	54.7 ± 8.8
Duration of surgery (min)	159 ± 51
Duration of anesthesia (min)	232 ± 57
Postoperative numeric rating scale	37 ± 19

Values are given as means ± SD

Intravenous lidocaine has analgesic, antihyperalgesic, and anti-inflammatory properties, which are mediated by a variety of mechanisms, including sodium channel blockade and the inhibition of G protein-coupled receptors and N-methyl-D-aspartate receptors [11,12]. Kaba et al. [13] reported that 1.3–2.7 $\mu g \cdot ml^{-1}$ of lidocaine significantly reduced sevoflurane requirement, postoperative abdominal discomfort, and pain on movement. We suggest that a considerable proportion of the analgesic effect of a TAP block may depend on the rise in serum concentration of the local anesthetic. We also suggest that we should match the serum concentration of the local anesthetic in the treated group with that in a control group when assessing the analgesic effect of local anesthesia.

There are two limitations of this study. First, the local anesthetic used for the TAP block was lidocaine, which may be criticized for its short duration. In fact, 5 of the 12 patients did not report a decreased perception of pinprick sensation in the lower abdominal wall after their emergence from anesthesia. At this time more than 3 h had passed after the block. We suppose that this may have been because of the short duration of lidocaine. However, the main objective of this study was to investigate the serum concentration of the local anesthetic after a TAP block, not its analgesic properties. We used lidocaine because there are plenty of previous reports that have investigated the relationship between the serum concentration of lidocaine and its analgesic or adverse effects. Although the pharmacokinetic properties of lidocaine are not completely identical to those of ropivacaine or bupivacaine, we believe it is reasonable to extrapolate the results of this study to a TAP block with other local anesthetics.

Second, the serum concentration of lidocaine after the TAP block was investigated while patients were under general anesthesia. The metabolism of lidocaine is significantly affected by hepatic blood flow [14]. Although the findings are controversial, propofol is

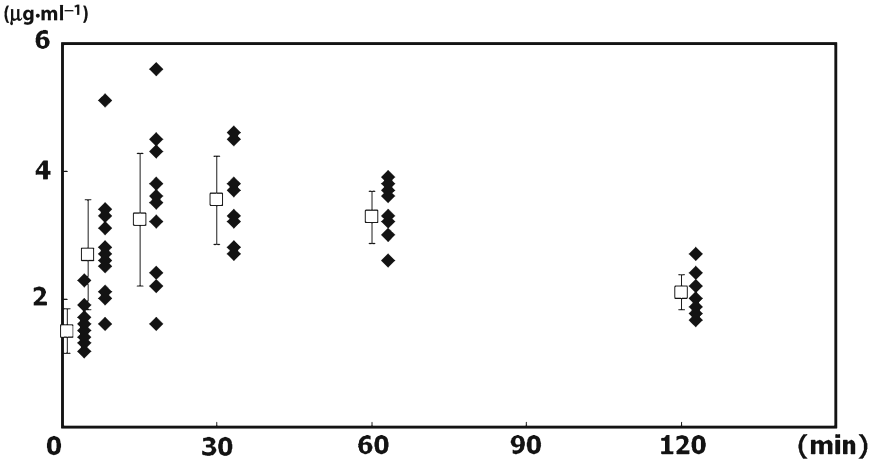

Fig. 1. Serum concentration of lidocaine after transversus abdominis plane block. *Black diamonds*, Individual data ($n = 12$); *open squares*, means ± SD

reported to alter hepatic blood flow [15,16]. Thus, if the serum concentration of lidocaine had been measured in awake patients, the results of this study might have been different.

In conclusion, a TAP block was associated with a significant increase in the serum concentration of a local anesthetic. A TAP block can potentially cause systemic toxicity of local anesthetics. The analgesic effect of a TAP block may partially depend on the rise in the serum concentration of the local anesthetic.

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