



ウサギの尾椎脊柱管へのブピバカイン単回注入の効果

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## 学 位 論 文 要 旨

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<p>[論文題名]</p> <p>Effects of a Single-bolus Bupivacaine Injection into the Coccygeal Spinal Canal of Rabbits (ウサギの尾椎脊柱管へのブピバカイン単回注入の効果)</p> <p>The Journal of Veterinary Medical Science, accepted, 15 pages.</p>			
<p>[要 旨]</p> <p>In the present study, the effects of a single-bolus bupivacaine injection into the coccygeal spinal canal of rabbits were evaluated using a new technique for coccygeal epidural anesthesia of rabbits, which I and co-author developed. In animals, epidural anesthesia and analgesia are frequently administered by inserting a needle into the epidural space through the lumbosacral junction to deliver local anesthetics for the procedure involving caudal part of the body, such as hindlimbs, pelvis, perineum, and tail. This technique has also been used in rabbits. In rabbits, it has been reported that drugs intended for epidural administration through the lumbosacral junction are often accidentally administered into the subarachnoid space. One of the reasons could be due to the spinal cord ended at the sacral vertebrae in rabbits. Subarachnoid administration of epidural dose may cause an excessive cranial spread of the drug and spinal cord puncture may cause spinal cord injury. Clinically, drug injection into the sacrococcygeal epidural space has been performed in some animals especially cats. As the spinal cord of rabbits ends at the sacral vertebrae, we assumed that an intercoccygeal injection was safer than the conventional lumbosacral approach to avoid a subarachnoid injection.</p> <p>Six healthy male Japanese White Rabbits were used. Each rabbit underwent two experimental trials at 14-day intervals. Thereafter, either 0.3 ml/kg of 0.5% bupivacaine or 0.3 ml/kg of normal saline was randomly administered via epidural in separate trials. Under general anesthesia with isoflurane, rabbits were placed in sternal recumbency with elevated hip. A 70-mm-long 27-gauge spinal needle was inserted percutaneously at the dorsal tail base in caudocranial direction. Following the confirmation of the needle tip placement in the vertebral canal, iohexol was administered. The needle was readjusted when the contrast was observed at sites besides the epidural space until it was identified in the epidural space only. If the contrast was found only in the epidural space on radiographs, either 0.3 ml/kg bupivacaine 0.5% (n=6)</p>			

or 0.3 ml/kg normal saline (n=6) was randomly injected through the needle in a blinded manner. Pulse rate and blood pressure (non-invasive monitoring) were recorded at 1 minute before and 1, 5, 10 minutes after the injection. At 2 minutes after the injection, general anesthesia and oxygen supply was discontinued. Neurological examination was assessed in blinded fashion before and every 20 minutes after general anesthesia until all findings back to normal, and reassessed one week later. Arterial blood gas analysis was performed before general anesthesia and at 30, 60, and 120 minutes following epidural injection.

After the first attempt of iohexol injection, although the contrast was found in epidural space in all rabbits, the additional contrast line was also found ventral to vertebrae in 3 rabbits and in the muscular layer in 1 rabbit. Among these 4 rabbits, in 2 rabbits, contrast was found only in the epidural space at the second attempt. In other 2 rabbits, contrast was found only in the epidural space at the third attempt. The time taken to regain normal anal reflex, movement of the hindlimbs during walking, conscious proprioception of the hindlimbs, pain sensation of the left hindlimb and tail following coccygeal spinal canal injection, were significantly longer in the bupivacaine group than in the normal saline group. The changes in blood gas data, pulse rate and blood pressure in all groups were not significant.

After bupivacaine injection, in all rabbits, only anal reflex, movement of the hindlimbs during walking, pain sensation of the left hindlimb and tail were affected, but the forelimbs were not affected. The results indicate that bupivacaine injected into the coccygeal epidural space could block some of the motor and sensory nerves that innervate the hindlimbs, tail, and perineal region. The blood gas data did not significantly change after bupivacaine injection, indicating that the coccygeal epidural injection of bupivacaine has minimal effect on respiratory function. The immediate cardiovascular effects of coccygeal epidural administration with bupivacaine appeared to be negligible as there was no significant change in blood pressure within the bupivacaine group.

The contrast was observed in the epidural space but not in the subarachnoid space in all rabbits after the coccygeal spinal canal injection of iohexol. Our result was opposite to a previous study where injecting the contrast agent via epidural through the lumbosacral junction resulted in its entry into the subarachnoid space of all 7 rabbits. As the spinal cord of rabbits ends at the sacral vertebrae, injection at the coccygeal site will be distributed to epidural space and less likely to subarachnoid space. However, in some rabbits, an additional contrast line ventral to vertebrae, potentially blood vessel, was observed. In humans, a similar contrast linear line was observed after the epidural administration of contrast agent and was considered to be a blood vessel. In cats and dogs, inadvertent intravascular injection is a complication associated with epidural administration. Thus, in the present study, the contrast line ventral to the sacral and coccygeal vertebrae may be attributed to the entering of contrast agent into the blood

vessel. However, since there is no active flow of blood from the needle hub that was observed before iohexol injection, a question arose of how the contrast agent entered into the vessels without direct vascular injection with a needle.

In 10 rabbit cadavers, methylene blue with iohexol or Indian ink with iohexol were injected into the coccygeal spinal canal before radiographs were taken. Then, macroscopic and histological examinations of the tail were performed. In the cadavers with additional contrast lines on the radiograph, Indian ink was also detected in vessels outside the spinal canal macroscopically. Histologically, Indian ink was found in small vessels in the coccygeal spinal canal despite the absence of large vessels into which the 27-gauge needle could enter. In all cadavers, erythrocytes were found inside and outside of vessels in the coccygeal spinal canal.

The contrast line on the radiograph was considered to be the blood vessel because its presence was consistent with the Indian-ink-stained vessels outside the spinal canal. The outer diameter of a 27-gauge spinal needle that we used was approximately 4-fold larger than the largest vessel within the coccygeal spinal canal in the rabbits that we used. The presences of erythrocytes outside of vessels in the coccygeal spinal canal indicate injury of blood vessels, possibly due to needle insertion. Thus, an epidural drug may enter into the blood vessels via torn vessel without direct intravascular injection.

In conclusion, administration of 0.3 ml/kg 0.5% bupivacaine into the coccygeal spinal canal could provide sensory and motor block to the hindlimbs, tail, and perineal region in rabbits. However, incorrect needle placement and inadvertent vascular entry of the epidural drug were noted in some rabbits. Further studies are required to improve this technique and to determine the optimal dosage or volume of bupivacaine.

備考 論文要旨は、和文にあつては2,000字程度、英文にあつては1,200語程度