Spinal Cord Effects from Lumbar Myelographic Injection Technique in the Dog

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ABSTRACT. To characterize spinal cord effects of needle placement using lumbar puncture myelography technique, lumbar puncture was performed in 5 dogs and computed tomography images of the spinal column were acquired in the transverse plane at the level of the puncture site after contrast injection and both before and after needle removal. The spinal cords were punctured during needle placement and parenchymal contrast enhancement was present in 4 of 5 dogs. Although no dogs exhibited overt neurological abnormalities following computed tomographic imaging, hemorrhage, gliosis and axonal degeneration were confirmed microscopically in all subjects. These results suggest that spinal cord morbidity is induced when lumbar myelography is performed using currently accepted technique.

KEY WORDS: canine, computed tomography (CT), myelography.

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Although myelography is useful for initial lesion localization and operative planning of spinal cord disease, the procedure may also be attendant with significant neurological morbidity and occasional mortality [3, 4]. Intrathecal administration of contrast material into the subarachnoid space at the level of the occipitotlantal junction may result in post-procedural seizures and a slight risk of needle puncture into the medulla oblongata or cervical spinal cord. Although lumbar puncture is considered safer than cisterna magna puncture, 5% of dogs that receive lumbar punctures have seizures even when non-ionic water soluble iodinated contrast agents are used [1]. It has been reported that injection into the subarachnoid space at the level of the caudal lumbar spine may result in spinal cord edema, cystic necrosis, myelomalacia, axonal necrosis and hydromyelia [3, 4, 6] using standard technique. Explanations for these sequelae include systemic toxicity or direct toxic effect of contrast medium on the spinal cord [2]. An another explanation is physical trauma resulting from contrast medium injection into spinal cord due to the spinal cord terminating caudal to L5–6 in some dogs. Species and individual variations in the location of spinal cord termination exist but are considered normal variations [5, 6]. The phenomenon of the spinal needle puncture through the spinal cord has been reported in cadavers [7], but no descriptions have been published using computed tomography (CT) to monitor cord effects of needle puncture. In this investigation, we characterized the severity of parenchymal trauma that may be attributed to spinal needle placement and parenchymal contrast dispersion as determined by CT and histopathology findings. All experiments were performed under animal experimental guidelines of Obihiro University of Agriculture and Veterinary Medicine.

Five beagle dogs (8.0–12.0 kg) were anesthetized by

intravenous injection with thiopental sodium (Ravonal®, Tanabe Pharmaceutical, Osaka, Japan) and maintained under anesthesia using inhalational halothane/O₂ (Fluothane®, Takeda Chemical Industries, Osaka, Japan). With the dog positioned in lateral recumbency, lumbar puncture was performed percutaneously through the L5–6 interarcuate foramen using a 23-gauge 70-mm spinal needle (Top Spinal needle®, Top, Tokyo, Japan). Cerebrospinal fluid backflow into the needle hub was used to confirm needle tip placement within the ventral aspect of the subarachnoid space. A non-ionic water soluble iodinated contrast agent (Iohexol, 240 mgI/ml, Omnipaque®240, Daiichi Pharmaceutical, Tokyo, Japan) was then injected into the subarachnoid space using an injection volume of 0.45 ml/kg. The X-ray penetrative platform is used for preventing needle movement during myelography through CT examination. With the needle still in place, each dog was kept laterally positioned within the gantry of the CT scanner (X vision Real™, Toshiba Medical, Tokyo, Japan) so that the spinal needle was aligned with the transaxial image acquisition plane. CT myelographic images were obtained before and after removal of the spinal needle. Images were acquired using a 24 cm field of view, 120 kVp, 200 mA, 0.8 mm slice thickness and a standard filter. All dogs were recovered from anesthesia immediately following CT imaging and were observed for neurological abnormalities. Dogs were then euthanized and the spinal cords were removed from the level of L1 to L6 vertebral column the following day. A thin, transverse section of the spinal cord of each dog, corresponding to the level of L5–6 and including the spinal needle tract, was preserved in 10% buffered formalin. Specimens were routinely processed and embedded in paraffin wax for staining with hematoxylin and eosin, and microscopic abnormalities were characterized in each sample using a semiquantitative numerical scale (0=normal, 1=mild, 2=moderate, 3=severe).

Transverse CT images of the spinal canal acquired after

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Fig. 1. Transverse computed tomography (CT) images of a normal dog acquired at the level of L5–6 following spinal needle placement and intrathecal contrast administration. 0.8 mm slice, WL=+479, WW=4168. A) CT image acquired with needle in place. Note that the spinal cord has been punctured by spinal needle. B) The same section as in A following removal of the spinal needle. Contrast enhancement of spinal cord parenchyma is evident in the location of the needle track (arrow).

Fig. 2. Photomicrograph of a spinal cord cross-section from the same dog showed as in Fig. 1. The fragmented line extending from the dorsal to the ventral margin of the cord represents the needle track (arrow). There is evidence of gliosis and axonal degeneration adjacent to this track.

Fig. 3. Photomicrograph of a spinal cord cross-section following CT myelography. This section was harvested at the level of the L5–6 injection site. A focal region of hemorrhage, axonal degeneration and gliosis is present in the mediodorsal aspect of the spinal cord. The point of needle puncture can be seen in the dorsal dura mater (arrow).

intrathecal contrast administration are shown before and immediately following withdrawal of the spinal needle (Fig. 1, A and B). The spinal cord parenchyma was penetrated during needle placement in 4 of 5 dogs and contrast enhancement was seen within the spinal cord parenchyma on images acquired after spinal needle withdrawal in all four of these subjects. The spinal cord of one dog terminated cranial to the L5–6 and in this instance the needle passed through the cauda equina. The termination of the spinal cord is individual difference, and there is also specific difference [5]. So the fact there exist dogs present symptom

Table 1. Histopathological findings of the spinal cord at the level of L5–6 after CT myelography

Dog	#1	#2	#3	#4	#5	average
Gliosis	1	0	0	0	1	0.4
Axonal degeneration	2	1	1	2	2	1.6
Hemorrhage	3	2	0	3	2	2.0

0=normal, 1=mild, 2=moderate, 3=severe.

and dogs do not present any sign is explicable. Myelography is generally considered to puncture the site of cauda equina because the spinal cord is thought to end cranial to L6. In human medicine, myelography is performed at the L3–4 or L4–5 puncture site but the needle does not puncture the spinal cord because the cord terminates at L2 in people. Myelographic technique in veterinary medicine is similar, but the anatomical differences make myelography in the dog potentially a higher risk. Although no clinically identifiable neurologic deficits were present in any of the 5 dogs following anesthetic recovery, microscopic examination revealed variable hemorrhage, axonal degeneration and gliosis (Figs. 2 and 3, Table 1). These may be attributed to a combination of direct trauma from needle placement and chemical toxicity of contrast medium [2].

In conclusion, results of our study suggest that adverse effects on the spinal cord from direct needle trauma and from parenchymal contrast dispersion may be more pronounced than previously thought. Although no gross clinical

sequela resulted from myelography procedures performed in this investigation, the histological findings of hemorrhage and axonal degeneration suggest that potentially significant morbidity is induced when lumbar myelography is performed using currently accepted technique.

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