FULL PAPER **Surgery**

Application of Short-time Magnetic Resonance Examination for Intervertebral Disc Diseases in Dogs

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ABSTRACT. The usefulness of magnetic resonance (MR) is already established, but it has a disadvantage of requiring a long scanning time. A short-time examination is more or less needed so as to be more practical in veterinary clinics. A protocol of the short-time MR examination was devised based on parameters determined, and validity of the protocol was assessed through the diagnosis of clinical cases with intervertebral disc diseases. With this protocol, it was possible to complete an MR examination for the spine within 15 min. The MR images and myelographic findings were correlated well in this study, suggesting the short-time protocol of MR examination can be used in the clinical diagnosis of spinal diseases.

KEY WORDS: anesthesia, canine, magnetic resonance (MR), myelography, spine.

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Radiographic myelography is an important method for diagnosing spinal diseases. With the advent of non-ionic contrast agents [1, 6], the safety of radiographic myelography has remarkably improved, but radiographic myelography is sometimes difficult to use in obese animals and it cannot be denied that this procedure entails substantial intervention with vertebral canal puncture [3, 5]. The usefulness of magnetic resonance (MR) has already been established; it enables the clinician to delineate the lesion three-dimensionally with a non-invasive method. In addition, not only compressive lesions but degeneration, edema or other lesions, which cannot be delineated by myelography or computed tomography (CT), can be delineated, but it has the disadvantage of requiring a long scanning time. As in CT, a shorter scan time may be more practical and widely available in veterinary practice, but there have been no reports on a short-time protocol for MR in the diagnosis of the spinal diseases in the dog. This study was conducted to establish a short-time MR protocol for spinal diseases and to apply it for clinical cases with intervertebral disc diseases.

MATERIALS AND METHODS

MR images were obtained with a 1.5 tesla magnetic field strength (VISART™, Toshiba, Tokyo, Japan) consisting of a superconducting magnet equipped with a surface coli. Slice thickness was 1.5 mm, and the matrix was 256 × 256 in all images.

For radiographic myelography, iohexol (Omnipaque 300®, Daiichi Pharmaceutical Co., Tokyo, Japan, 300 mgI/m*l*), a non-ionic, water-soluble iodinated contrast agent, was injected into the subarachnoid space at a dose of 0.4 m*l*/kg with a 70-mm, 23-gauge spinal needle.

As MR images are strongly dependent on the instrument parmeter settings [2], the parameters for short-time examination were assessed in 3 healthy adult beagles, comparing contrast, signal to noise ratio (S/N) and scan time in different parameters [7]. Subsequently the validity of the protocol was examined in 3 dogs with pain or neurologic deficits and suspected of having intervertebral disc diseases, and referred to the Veterinary Teaching Hospital of Obihiro University of Agriculture and Veterinary Medicine. Thiopental injection (15–25 mg/kg, RAVONAL®, Tanabe, Osaka, Japan) is used for anesthesia, and placed on spontaneous respiration via an intratracheal tube during MR scanning in clinical cases.

RESULTS

Establishment of parameters: Appropriate parameters of the first spin echo pulse sequence were obtained by comparing images at repetition time (TR) of 2,000, 3,000 and 4,000 msec, and with a number of echoes per TR of 11, 17 or 23 times, respectively (Fig. 1). Echo time (TE) was fixed at 120 msec, at which the scan time was not affected. The scan time of each images is shown in Table 1. The longer the TR and the fewer the number of echoes per TR, the higher the S/N obtained and the longer the scan time. With shorter TR, and the greater the number of echoes per TR, the lesser the S/N and the shorter the scan time. In consideration of the S/N, contrast between tissues and the scan time, a TR of 3,000 msec, and the number of echoes per TR of 17 times were selected as parameter for the T_2 weighted image. A sagittal image of the spine obtained with the determined parameter setting is shown in Fig. 2. This image was a 1.5 mm slice obtained with a 256 matrix, 4 data averagings and a scan time of 6 min 3 sec. Cerebrospinal fluid (CSF) was depicted at high signal intensity. The epidural fat would also have as high a signal intensity as the cerebrospinal fluid. There was

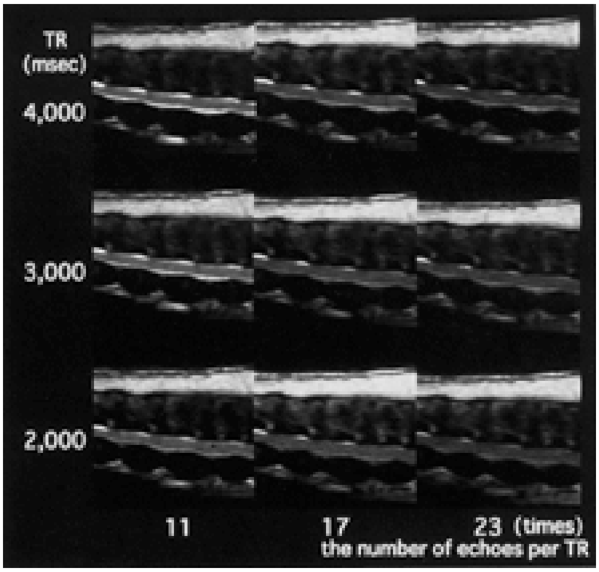

Fig. 1. Investigation of the T_2 weighted image sequences of the spine. TR (2,000, 3,000 and 4,000 msec in the horizontal panel) and the number of echoes per TR (11, 17 and 23 times in the vertical panel) are shown. TE is fixed at 120 msec, 256 matrix and 4 image averagings. The scanning time (min:sec) for each image is described in the next matrix. In consideration of the S/N, contrast between tissues and the scan time, a TR of 3,000 msec, and the number of echoes per TR of 17 times were selected as determined parameter for the T_2 weighted image.

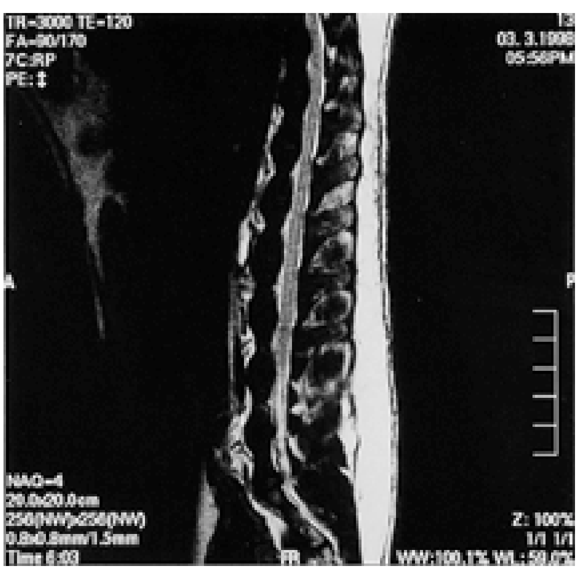

Fig. 2. A sagittal T_2 weighted image of the spine obtained with the determined parameter settings in a healthy beagle. (fast spin echo, TR/TE/the number of echoes per TR=3000 msec/120 msec/17 times, 1.5-mm slice, scan time 6 min 3 sec)

a sharp contrast between the CSF and spinal cord.

The protocol of MR examination for the spine: The protocol of the MR examination prepared based on the parameters

Table 1. The scan time (min:sec) of each image in Fig. 1

12:20	8:04	5:56
9:15	6:03	4:27
6:10	4:02	2:58

Table 2. The protocol of MRI examination for the spine

1	Transverse scout view	0:20
2	Dorsal-plane scout view	0:20
3	Sagittal T_2 weighted image	6:03
4	MR myelography	4:35
		(min:sec)

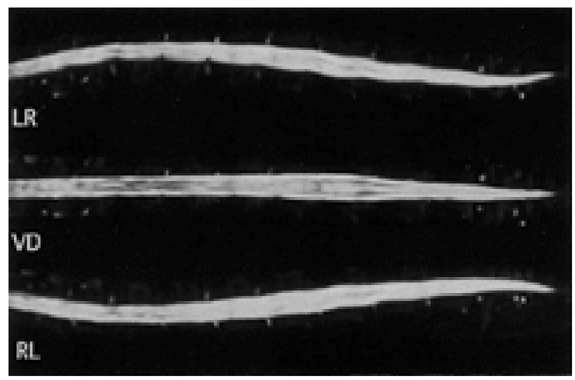

Fig. 3. Representative MR myelography of a normal beagle. Figure 3 shows LR, VD and RL views, it is possible to observe the cerebrospinal fluid by 3-dimensional rotating every 15 degrees without using any contrast agent.

determined is shown in Table 2. The dorsal plane and transverse scout views were each scanned for 20 sec. Sagittal T_2 weighted images were then scanned for 6 min 3 sec, followed by MR myelography (Fig. 3) with scanning for 4 min 35 sec. MR myelography visualizes CSF three-dimensionally without the use of any contrast agent by the maximum intensity projection image processing method of heavy T_2 weighted images (fast advance spin echo, TR/TE/inversion time=5,000/250/150 msec). With this protocol it is possible to complete the examination within 15 min.

Clinical case #1: A 4-year-old female Beagle dog (14.5 kg) presented with paraplegia of the hindlimb. A herniated intervertebral disc in the lumbar region was suspected due to lower motor neuron (LMN) signs. MR revealed spinal cord compression at L5-L6 and L6-L7 levels (Fig. 4, a, arrows). Interceptions of the contrast agent were observed at L5-L6 and L6-L7 on myelography (Fig. 4, b, arrows). MR myelography provided the same information as in sagittal T_2 weighted image and myelography. Although their relation to the clinical manifestation was unclear, Fig. 5 (a, b, c) shows a type I vertebral disc protrusion which extended not only to the intervertebral disc but also the vertebrae (T12, T13) from the ventral right, causing cord compression. This was confirmed on the ventrodorsal image of the myelography (Fig. 5,

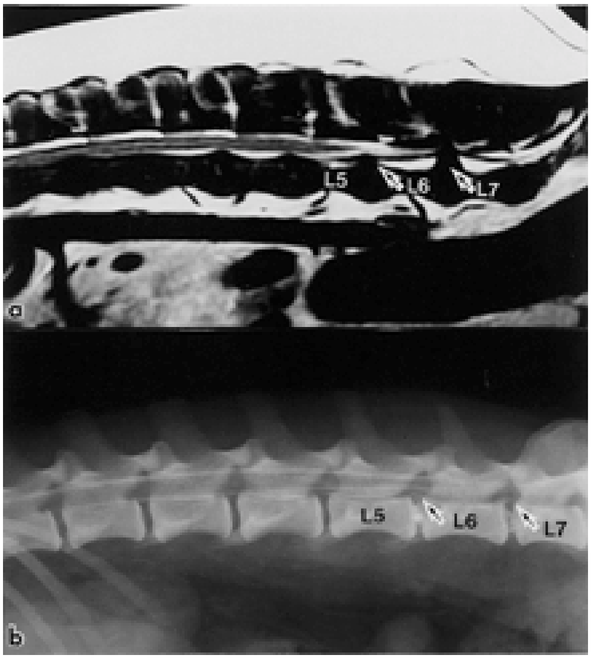

Fig. 4. A sagittal T_2 weighted image (a, fast spin echo, TR/TE/the number of echoes per TR=3000 msec/120 msec/17 times, 1.5 mm slice, scan time 6 min 3 sec) and lateral myelogram (b) of the lumbar spine in case #1. MR revealed spinal cord compression at L5-L6 and L6-L7 levels (a, arrows). Interceptions of the contrast agent were observed at L5-L6 and L6-L7 on myelography (b, arrows).

d, arrow).

Clinical case #2: A 9-year-old male Dachshund (8.6 kg) presented with quadriparesis and cervical pain was suspected of having cervical intervertebral disc disease. MR examination demonstrated intervertebral disc protrusion in C2-C3 (Fig. 6, a, arrow). The compression at C2-C3 was also evident on myelography (Fig. 6, b, arrow). MR myelography provided the same information as in a sagittal T_2 weighted image and myelography.

Clinical case #3: A 12-year-old male Beagle dog (18.4 kg) presented with paresis of the hindlimb. A intervertebral disc herniaiton in the lumbar region was suspected due to LMN signs. Multiple disc protrusions within the lumbar spine region were observed on MR (Fig. 7, a, arrows), and were also evident on myelography (Fig. 7, b, arrows). MR myelography provided the same information as in sagittal a T_2 weighted image and myelography. The case was diagnosed as spondylopathy. The owner opted for euthanasia. Gross pathologic findings verified these findings.

DISCUSSION

This investigation represents an attempt to establish parameters for MR examination of the spine of dogs and devises a protocol for short-time MR examination. With the determined parameters obtained it was found feasible to scan

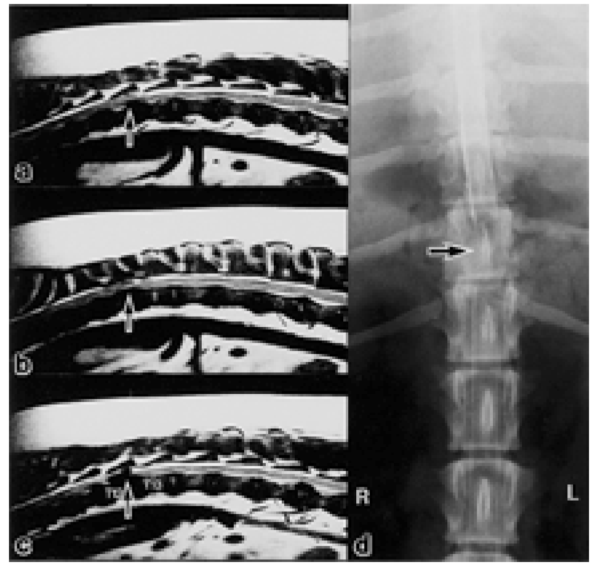

Fig. 5. Sagittal T_2 weighted images represent a type-I vertebral disc protrusion at T12–13 from the ventral right (a, b, c, arrows). This was also demonstrable in the myelography ventrodorsal image (d, arrow). (a, 1.5 mm left of midline, b, at the midline, c, 1.5 mm right of midline, d, ventrodorsal myelogram)

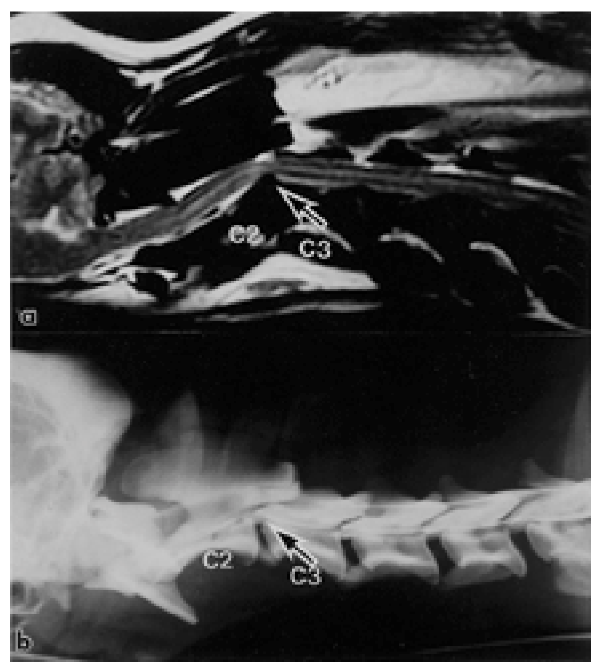

Fig. 6. A sagittal T_2 weighted image (a, fast spin echo, TR/TE/the number of echoes per TR=3000 msec/120 msec/17 times, 1.5 mm slice, scan time 6 min 3 sec) and lateral myelogram (b) of the cervical spine in case #2. MR examination demonstrated intervertebral disc protrusion in C2-C3 (a, arrow). The compression in C2-C3 was also evident on myelography (b, arrow).

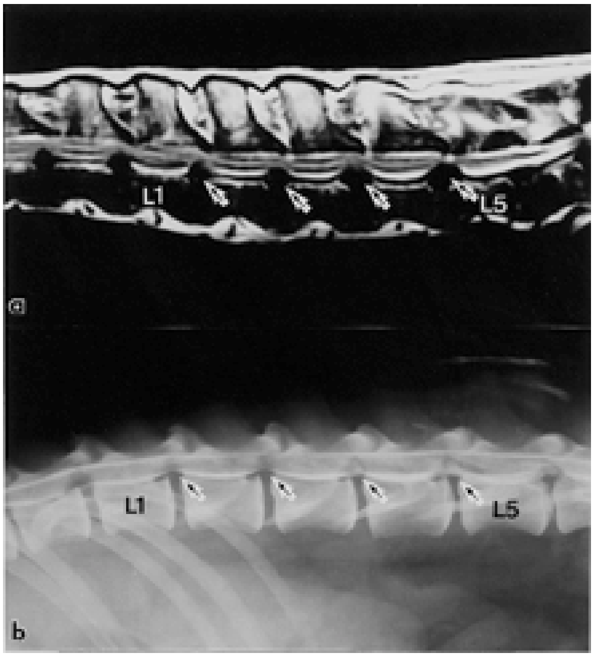

Fig. 7. A sagittal T_2 weighted image (a, fast spin echo, TR/TE/the number of echoes per TR=3000 msec/120 msec/17 times, 1.5 mm slice, scan time 6 min 3 sec) and lateral myelogram (b) of the lumbar spine in case #3. Multiple disc protrusions within the lumbar spine region were observed on MR (a, arrows), and were also evident on myelography (b, arrows).

1.5 mm thin slices, thus involving less partial-volume effects. With this protocol, it was possible to complete an MR examination within 15 min from the time the patient was brought in till the time it was taken out of the examination room. This made it possible to do this procedure under short-time intravenous anesthesia with thiopental, propofol or other chemical restraint enough for short-time immobilization. We did not scan the transverse image except for scout views because of low S/N in small fields of transverse images, hence scarcely affording additional diagnostic information. If diagnostic transverse images with numbers of data averaging are scanned, it requires a longer, therefore inadequate scan time for this protocol. We found that MR myelography provides information about lateral compression as well as transverse images (unpublished data), but we do not deny detailed long-time MR examination including transverse images and additional T_1 weighted images; but with long-time examination there are more likely to be accidental motion artifacts. The short-time protocol of MR examination can be more practical in the clinical diagnosis of spinal diseases.

The results of MR were in close accord with those of radiographic myelography, and the two methods proved to be comparable in diagnostic performance. MR is advantageous over radiographic myelography in that it entails no use of contrast agents, so that there is no risk of adverse effects of iodine contrast agents. Doses of contrast agents are rather intricate, and failure in radiographic myelography due to disregard of breed type has been encountered [4]. MR does not require shaving or surgical disinfection, or intervention with vertebral canal puncture. Differing levels of skill do not produce noticeable differences in imaging outcome, which would make interpretation of the myelogram difficult. There is no such interference as enhancement of the epidural space. Above all, the examination can be completed within a short-time. Current problems are its high cost and practicability because of the use of a high magnetic field strength MR unit, but these problems will be solved in the near future by widespread application of MR units. The protocol of the non-invasive, short-time MR examination can be a new option for imaging diagnosis in clinical veterinary work.

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