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Evaluation of Traumatic Intracranial Hemorrhage Using Computed Tomography and Magnetic Resonance Imaging in Four Dogs

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Abstract : Four dogs with neurologic dysfunction resulted from intracranial hemorrhage by head trauma were referred to Veterinary Medical Teaching Hospital, Chungnam National University. There were no remarkable findings in survey radiography in four cases. CT and MRI scans were diagnostic in these cases. Three dogs underwent CT scanning. On CT images, the lesion was hyperdense and was not enhanced after intravenous contrast administration in dog 1 and dog 2. On CT of dog 4, there was no significant finding. All of four dogs were verified by dorsal, sagittal, and transverse T1-weighted (T1W) and T2-weighted (T2W) images. Appearance of the lesions in dog 1 and dog 2 was isointense (dog 2) or isointense with hyperintense rim (dog 1) on T1W images and hyperintense on T2W images. In dog 3 and dog 4, there were hypointense and hyperintense lesions on T1W and T2W images respectively. The lesions in four dogs were located in the left intracerebral region, intracerebral and cerebellovestibular region, subdural space, and right cerebral hemisphere, respectively.

Key words : canine, CT, head trauma, intracranial hemorrhage, MRI.

Introduction

Head trauma and intracranial hemorrhage are common in both people (5,9,14) and animals (4). Brain injuries in animal are most often due to traffic accidents; other causes include falls, kicks, gunshot or pellet wounds and bites from larger animals (6,18,19,22). There are numerous clinical signs of intracranial hemorrhage that depends on a region and degree of hemorrhage (4,13,19).

Diagnostic tools of intracranial hemorrhage are computed tomography (CT) and magnetic resonance imaging (MRI) (4,14,16,22,24). Survey radiographs are not helpful for the diagnosis of intracranial hemorrhage (19). CT and MR imaging provided information on localization and change of adjacent neural structures (23,24).

This report describes the use of CT and MRI to evaluate four dogs with head trauma and reviews the MRI features of intracranial hemorrhage.

Materials and Methods

Traumatic intracranial hemorrhage was suspected in four dogs with history of head trauma. Survey radiography was performed in all of dogs. Four MRI studies and three CT studies were examined. All cases were anesthetized by isoflurane for the imaging procedure. MRI was performed with a 0.2 Tesla magnet (VET-MR®, Esaote, Italy). Non-contiguous (with an interslice gap of 0.5 mm) transverse images of slice thickness from 5 mm were generated with T1-weighted (T1W), T2-weighted (T2W) images. All four dogs were verified by dorsal, sagittal and transverse T1W and T2W MR images. CT (CTmax®, GE, USA) of the cranium in transverse plane using brain window (window 250, level 20) was performed with a thickness of 5 mm.

Results

Four patients aged 1 year to 8 years. All four dogs were small breed dogs and three of them were female. The breeds represented were one Shih-Tzu, two Maltese and one mongrel.

Presence of an intracranial hemorrhage was identified by CT and/or MRI (Table 2). On CT images, the lesions were hyperdense compared to gray matter in dog 1 and dog 2. The lesions were not enhanced after intravenous contrast administration (Omnipaque®, Nycomed, Norway). There was no significant finding in CT of dog 4. On MR images, appearances of the intracranial hemorrhage in two dogs were isointense

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Table 1. Data from four dogs with traumatic intracranial hemorrhage

Dog	Age/sex/breed	Clinical sign	Dx tool	Lesion location	Concurrent disease	Follow-up
1	1y F Shih-Tzu	Paralysis Nystagmus	MRI CT	Lt. intracerebral hemisphere	No	Death
2	8y M Mongrel	Seizure Head tilt Nystagmus	MRI CT	Intracerebral Cerebellovestibular	No	Mild neurologic sign
3	1y F Maltese	Paralysis SC hemorrhage	MRI	Subdural	Intracranial arachnoid cyst	Normal
4	1y F Maltese	Paralysis Head tilt	MRI CT	Rt. Cerebral hemisphere	No	Death

Dx: diagnosis F: female M: male Lt: left Rt: right SC: subcutaneous

Table 2. CT and MRI characteristics of age of intracranial hemorrhage in four dogs

Dog	CT		MRI			CT & MRI Contrast enhancement
	Time after trauma	CT characteristics	Time after trauma	T1W	T2W	
1	10 hours	hyperdense	4 days	isointense with hyperintense rim	hyperintense	No
2	5 days	hyperdense	2 days	isointense	hyperintense	No
3	-	-	2 days	hypointense	hyperintense	No
4	1 day	isodense	2 days	hypointense	hyperintense	No

(dog 2) or isointense with hyperintense rim (dog 1) on T1W images and hyperintense on T2W images. In dog 3 and dog 4, there were hypointense and hyperintense lesions on T1W images and T2W images, respectively.

The clinical signs and location of intracranial hemorrhage are summarized in Table 1. The lesion in dog 1 was located in the left intracerebral (Fig 1, 2) region, intracerebral and cerebellovestibular (Fig 3, 4) region in dog 2, subdural space (Fig 5) in dog 3, and general right intracerebral (Fig 6, 7) region in dog 4, respectively.

The presenting symptoms included paralysis (dog 1, 3, 4), seizure (dog 2), astasia (all 4 dogs), head tilt (dog 2, 4), bilateral nystagmus (dog 1, 2), tetraparesis (dog 2), and depression.

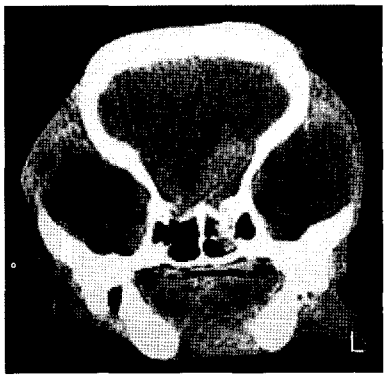

Fig 1. Pre-contrast transverse CT image of brain of dog 1 at the level of the temporomandibular joint from an 1-year-old female Shih-Tzu with head trauma. The hyperdense at left cerebrum and nasal cavity was shown.

There was no significant finding in complete blood count and serum chemistry.

Four dogs were treated medically. Dog 1 and dog 4 didn't respond to therapy for head trauma with antibiotics, colloidal

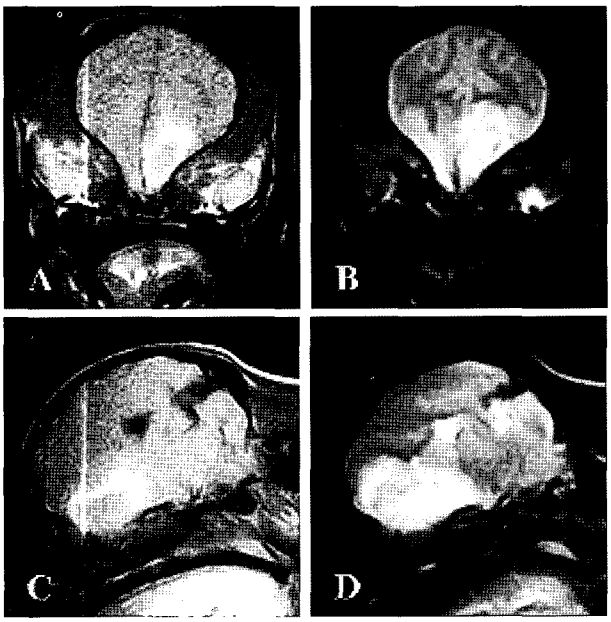

Fig 2. Pre-contrast T1W (A, C) and T2W (B, D) MR images of brain in dog 1 with paralysis and nystagmus. There was isointense lesion with hyperintense rim on transverse T1W image (A) and hyperintense on T2W image (B) at the level of temporomandibular joint. On this sagittal T1W (C) image revealed isointense with hyperintense rim.

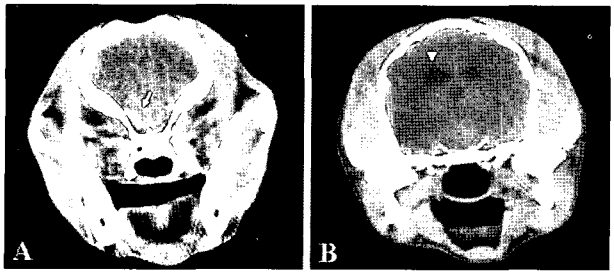

Fig 3. Pre-contrast transverse CT images of brain of dog 2 at the level of the frontal lobe (A) and temporomandibular joint (B). Note the hyperdense lesion (arrow) at right frontal lobe and asymmetric ventriculomegaly (arrowhead).

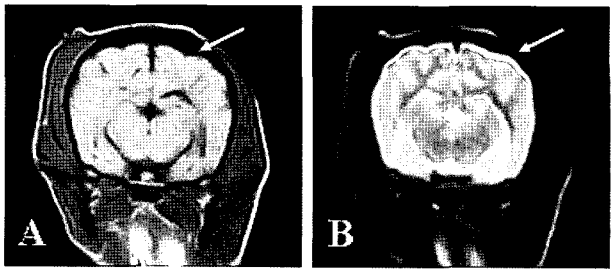

Fig 5. Pre-contrast T1W (A) and T2W (B) MR images of brain in dog 3 with paralysis. There are hyperintense and hypointense lesions (arrow) on transverse T2W and T1W images at the level of temporomandibular joint respectively.

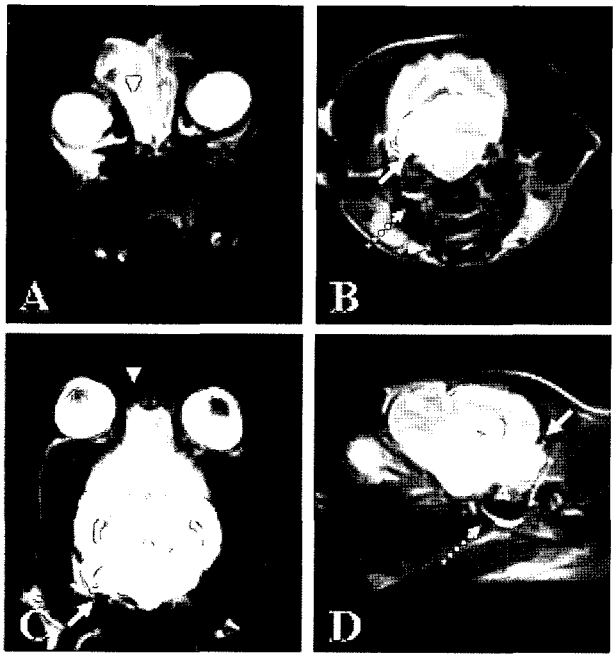

Fig 4. Pre-contrast T2W MR images of brain in dog 2 with head trauma. On this transverse T2W images at the level of fontal lobe (A) and tympanic cavities (B) there are hyperintense lesions in right frontal lobe (arrowhead) and right region of cerebellum (arrow). Note the hyperintense material (dotted white arrow) in right tympanic cavities. There are hyperintense lesions on this dorsal T2W images at the level of corpus callosum (C) and median plane images (D).

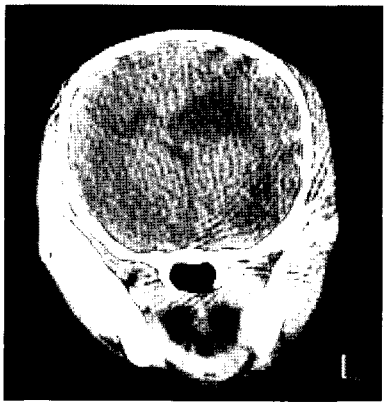

Fig 6. Pre-contrast transverse CT image of the brain of dog 4 at the level of the sulcus chiasmaticus from an 1-year-old female maltese with a head trauma. The asymmetric ventriculomegaly was identified.

fluid, diuretics and corticosteroids and were euthanized. At necropsy of dog 4, there was general hemorrhage in the right cerebral hemisphere.

Dog 2 and dog 3 were treated medically and improved remarkably. After medical therapy, patient's astasia and seizure decrease noticeably. The patient was getting better and received medical treatment with half-tapered dose. Symptoms with mild head tilt remained in dog 2 and dog 3 was normal. After medical treatments, MRI features revealed hemorrhagic infarction of cerebellum in dog 2 (Fig. 6) and no significant finding in dog 3.

Discussion

Intracranial hemorrhage is classified epidural, subdural, subarachnoid spaces, and intraparenchymal region of the brain in victims of traumatic brain injury (13,18). Epidural hemorrhage is accumulation of blood between the skull and dura mater, while subdural hemorrhage is accumulation of blood between the dura mater and arachnoid membrane. Subarachnoid hemorrhage is bleeding into the subarachnoid space and intraparenchymal hemorrhage is bleeding within brain parenchyma (13,18). Intraparenchymal hemorrhage is the most common in human (10), whereas subarachnoid and intraparenchymal hemorrhage are relatively common in animals (13). In this study, two patients(dog 1 and dog 4) were thought of intraparenchymal hemorrhage in the left or right cerebral hemisphere by head trauma. Dog 2 was considered as intraparenchymal hemorrhage with focal subdural hemorrhage in cerebrum and cerebellovestibular region by fall. The case of

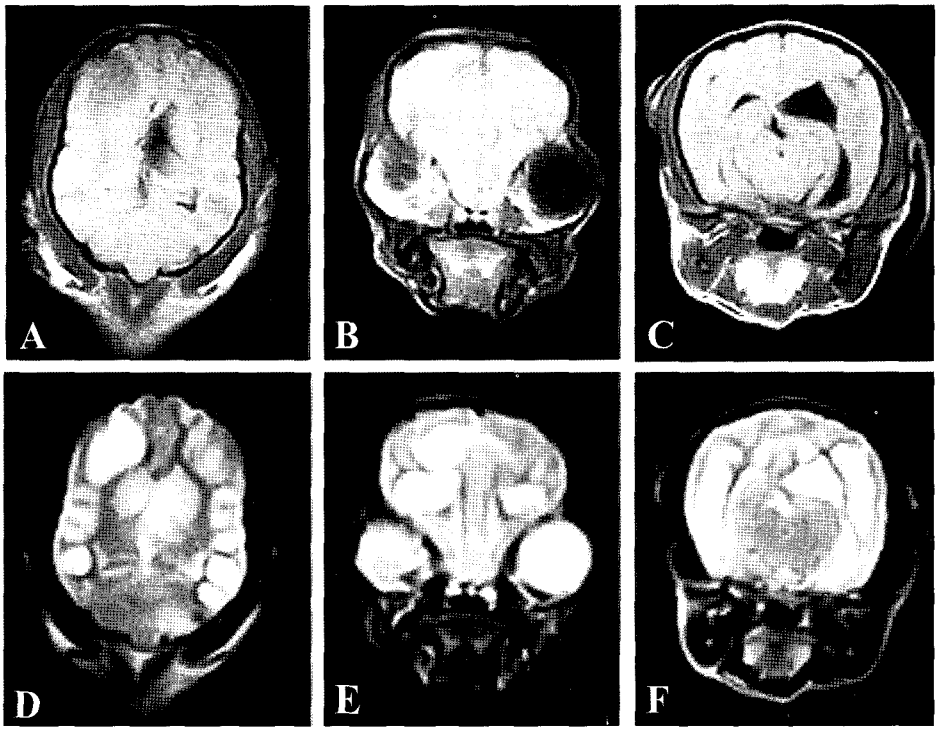

Fig 7. Pre-contrast T1W (A-C) and T2W (D-F) MR images of brain in dog 4 with head trauma. There are general hypointense and hyperintense lesions on T1W images and T2W images respectively. The asymmetric ventriculomegaly was identified.

Fig 8. T2W transverse MR images at the level of caudal fossa after medical treatment in dog 2. The well-demarcated hyperintense area (arrow) in the right parenchyma of the cerebellum was identified.

dog 3 was strongly suspected subdural hemorrhage.

Methods of diagnosis of intracranial hemorrhage are survey radiographs (4), ultrasonographs (17,24), CT and MR imaging (1,2,12,15,16,21,22,24). Survey radiographs were not helpful in identifying the intracranial hemorrhage in any of the patients in this study. Ultrasonographs is portable, inexpensive and does not subject patients to ionizing radiation (24). Compared to CT and MR, however, ultrasonographs have relatively lower sensitivity and specificity for intracranial hemorrhage (24). CT is often performed in patients with head trauma to identify fractures of the skull (8). Skull fracture is important to identify because it can increase the risk of CNS infection either as meningitis, encephalitis, abscess, or subdural empyema, which can occur soon after injury or be delayed (5). The CT characteristics of intracranial hemorrhage are diagnostic and CT is still the most common imaging modality used for evaluating acute intracranial hemorrhage due to its widespread availability, speed of the procedure, and compatibility with life support and monitoring devices (14,24). Previously reports, however, showed that MRI is able to detect hyperacute intracranial hemorrhage (1,2,12,15). MR imaging offers slightly better resolution and higher sensitivity, especially with minimal hemorrhage (14,20). MRI is extremely important when considering caudal fossa disorders, which are much more difficult to visualize on CT because of beam hardening artifact in this region (3,11,24). The case of dog 2 was positive result of cerebral hemorrhage in both CT and MRI and positive result of hemorrhage in the cerebellum by MRI but CT was negative because of beam-hardening artifact. Also, T2-weighted images are most useful for lesion detection, and T1-weighted images most useful for anatomic localization (10). The appearance of blood on MR imaging depends on the predominant type of hemoglobin present within the hematoma (14,16,24). Peracute hemorrhage appears isointense on T1-weighted images and isointense to slightly hyperintense on T2-weighted images (16). Acute hemorrhage is isointense to hyperintense on T1-weighted images and hypointens on T2-weighted images. Subacute hemorrhage appears hyperin-

tense on T1 and T2 weighted images. Chronic hemorrhage is hypointense signal on T1 and T2 weighted images (14,16). In this study, two patients (dog 1 and dog 2) were thought of peracute hemorrhage according to the characteristics of MR images. Dog 2 and dog 3 was considered as acute hemorrhage according to the time after head trauma. It is possible that these signal characteristics are not consistent with references because time of clinical stage was overlapping each other.

Prognosis of intracranial hemorrhage depends on the location and severity of the injury, and clinical symptoms (4,7,13). If patient's coma continued more than 48 hours, prognosis is grave (4,13). The prognosis is poor if stuporous and comatose with dilated unresponsive pupils and good with cerebellovestibular injuries (4). Dog 1 and dog 4 didn't respond to the therapy because of moderate intracerebral hemorrhage and continuous coma. Dog 2 and 3 were treated medically and improved remarkably. Dog 2 remained with mild head tilt and disequilibrium by hemorrhagic infarction of cerebellum.

We concluded that MR imaging and CT can be used in dogs to identify hemorrhagic lesions within the brain. If head trauma was suspected to be associated with skull fracture, it could be identified by X-ray or CT. MR imaging is more useful than other imaging modalities for diagnosis of intracranial hemorrhage.

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개에서 컴퓨터단층촬영술과 자기공명영상을 이용한 창상성 두개관내 출혈의 평가

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요 약 : 두개 창상에 의해 신경증상을 나타내는 4마리의 환자가 내원하여 일반 방사선 검사 및 컴퓨터단층촬영술(CT)과 자기공명영상(MRI)을 실시하였다. 일반 방사선 사진에서는 내원한 4마리의 개에서 모두 특이소견을 관찰할 수 없었다. 3마리 개에서 실시한 CT 결과, 3마리 중 2마리의 환자에서 전두엽 부위에 고밀도로 나타나는 병변을 확인할 수 있었으나 소뇌 부위의 병변은 관찰되지 않았다. 이어서 실시한 MRI 검사 결과, 일부의 환자에서는 T1-강조영상에서 저신호로 나타나고 T2-강조영상에서 고신호로 나타나거나 T1-강조영상과 T2-강조영상에서 각각 등신호, 고신호로 나타나는 병변을 확인할 수 있었다. 병변 부위는 좌측과 우측 대뇌 부위, 소뇌전정 부위, 경막하 부위로 다양했다. 이들 환자는 내과적 치료를 실시한 후, 임상적으로 호전되었음을 확인하고 일부 환자는 MRI를 통해 추적검사를 하였다.

주요어 : 개, 두부 창상, 두개관내 출혈, 자기공명영상, 컴퓨터단층촬영술