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MAGNETIC RESONANCE IMAGING OF THE BRAIN OF BACTRIAN CAMEL (*Camelus bactrianus*)

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ABSTRACT

Three specimen of the brain of adult camels were collected from the Minqin county Gansu China after slaughtering these animals by exsanguination in the local slaughterhouse and procedures described by Xie (1987) and Xie (2006) were followed. Magnetic resonance imaging was performed at Radiodiagnostic Service Centre of the Hospital of the Jinyuan Coal Corporation (Changzheng Canau, China) using a superconducting magnet operating at a field strength of 1.5 T (GE Signa Echospeed 1.5 T Tesla MRI Scanner, General Electric Medical Systems, Milwaukee, WI, USA). MR images were obtained in sagittal, transverse and horizontal planes with spin echo sequence. T1-weighted MR images were acquired using the following parameters: repetition time (T_R) = 200 ms, echo time (T_E) = 20 ms, 256 × 128 matrix, 1.0 cm slice thickness with 1 mm interslice spacing. For the T2-weighted MR images, the T_R was 4000 ms, T_E was 130 ms, 256 ×216 matrix, 1.0 cm slice thickness with 1 mm interslice spacing.

MRI T1-weighted image provided excellent anatomic description of the brain and associated structures. The brain structures (myelencephalon, pons, cerebellar vermis, cerebellar hemisphere, mesencephalon, cerebral hemisphere, thalamus, hypothalamus, hippocampus, pituitary gland, pineal body, fornix, etc.) had an intermediate signal intensity and appeared grey. The cortical grey matter was hypointense compared to white matter. The encephalic ventricular system had a reduced signal intensity.

On the T2-weighted images, the brain appeared dark and images were somewhat grainy. White matter of the brain appeared grey than the surrounding grey matter, and there was excellent tissue contrast. The lateral ventricle, 3rd ventricle, 4th ventricle and mesencephalic aqueduct had an intermediate signal intensity and appeared much darker.

Key words: Bactrian, brain, magnetic resonance imaging

Magnetic resonance imaging (MRI) techniques make slices taken through different parts of the living body which may be quantified to abstract useful 3-dimensional information. In humans, magnetic resonance imaging (MRI) is frequently used for imaging the central nervous system (CNS) without using ionising forms of electromagnetic energy. MRI is used for its ability to non-invasively produce high-detail, high-contrast, 2-dimensional, grayscale images of the brain. The complex anatomy and pathologic changes of the head and brain are better defined with MRI than with conventional radiology, scintigraphy or computed tomography (CT) (Arnold and Matthews, 2002). The superior contrast resolution of soft tissue provided by MRI facilitates diagnosis of many CNS lesions, including tumours and other degenerative abnormalities.

MRI has been increasingly used in veterinary medicine and has greatly enhanced the study of anatomy and pathologic changes. MRI has been utilised for the diagnosis of disorders of the spine (Widmer *et al,* 1991; Thomson *et al,* 1993), central nervous system (Duesburg *et al,* 1995) and musculoskeletal system of dogs (Bree *et al,* 1995). Reports of MR imaging in the equine species has been limited to imaging of cadaver parts. Disorders of the equine for which MRI of the brain may prove to be diagnostically beneficial include equine meningitis, hypoxic-ischaemic encephalopathy, cerebral oedema and intraventricular haemorrhage (Morgan *et al,* 1993; Arencibia *et al,* 2000). In addition, MRI may prove to be beneficial in illuminating pathophysiology and prognosis of various diseases. The use of MRI in large animal medicine is currently limited by the logistical problems acquiring MRI. In small animals, it is frequently used to evaluate the head (Karkkainen *et al,* 1991; Morgan *et al,* 1994; Smith *et al,* 2001). Arencibia *et al* (2005) investigated the cranioencephalic structures of the dromedary (*Camelus dromedarius*) by MRI. However, there have been no reports of MRI studies of the brain of bactrian camel.

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The objective of this study is to provide an overview of the normal cross-sectional anatomy of the postmortem brain structures of the bactrian camel using MRI.

Materials and Methods

Three specimen of the brain of adult camels were collected from the Minqin county Gansu China after slaughtering these animals by exsanguination in the local slaughterhouse and procedures described by Xie (1987) and Xie (2006) were followed. Magnetic resonance imaging was performed at Radiodiagnostic Service Centre of the Hospital of the Jinyuan Coal Corporation (Changzheng Canau, China) using a superconducting magnet operating at a field strength of 1.5 T (GE Signa Echospeed 1.5 T Tesla MRI Scanner, General Electric Medical Systems, Milwaukee, WI, USA). MR images were obtained in sagittal, transverse and horizontal planes with spin echo sequence. T1-weighted MR images were acquired using the following parameters: repetition time (T_R) = 200 ms, echo time (T_E) = 20 ms, 256 × 128 matrix, 1.0 cm slice thickness with 1 mm interslice spacing. For the T2-weighted MR images, the T_R was 4000 ms, T_E was 130 ms, 256×216 matrix, 1.0 cm slice thickness with 1 mm interslice spacing.

Evaluation of the sagittal, transverse and horizontal MR images was done and were compared to images of each bactrian camel and the anatomic structures that were consistently visible on images from all 3 camels were determined. Anatomic features were identified by referring to gross anatomical sections (Hillmann, 1975; Smuts and Bezuidenhout, 1987; Xie, 1987; Xie, 2006) anatomy. A fixed brain were also used for identifying details of morphology.

Results

MRI of the brain of these 3 bactrian camels produced excellent images that permitted detailed visualisation of many gross anatomic structures of the brain. The brain anatomic structures were identified and labelled in the corresponding photographs. Fig 1. is a transverse MRI of the brain. Lines represent the locations of T2-weighted transverse images. White and grey matter were easily distinguished. Transverse MR images are displayed such that the left of bactrian camel brain is to the viewer's right and dorsal is to the top of the image.

MRI T1-weighted image provided an excellent anatomic description of the brain and associated structures (Figs 2, 3). The brain structures (myelencephalon, pons, cerebellar vermis, cerebellar hemisphere, mesencephalon, cerebral hemisphere,

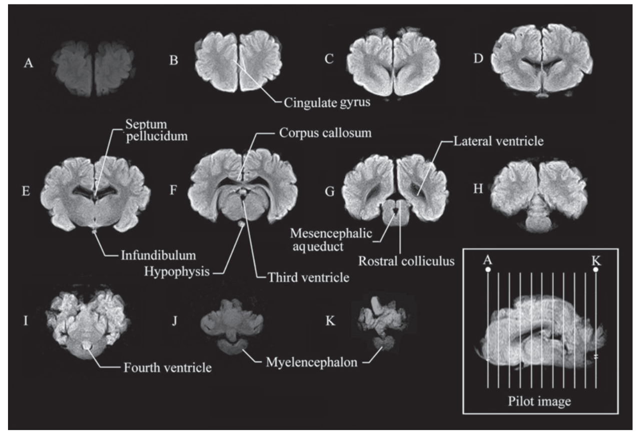

Fig 1. T2-weighted transverse MRI. (A-K) Successive transverse sections running in a rostrocaudal direction as indicated in the pilot image (bottom right).

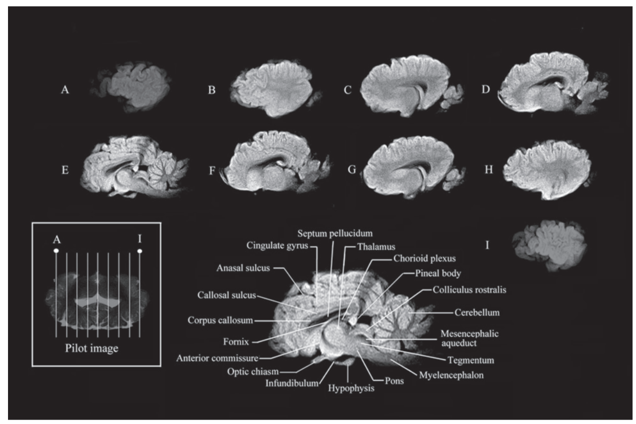

Fig 2. T1-weighted sagittal MRI. (A-I) Successive sagittal sections as indicated in the pilot image (bottom left). Bottom right: Enlargement of image E showing the midsagittal image details of the anatomy.

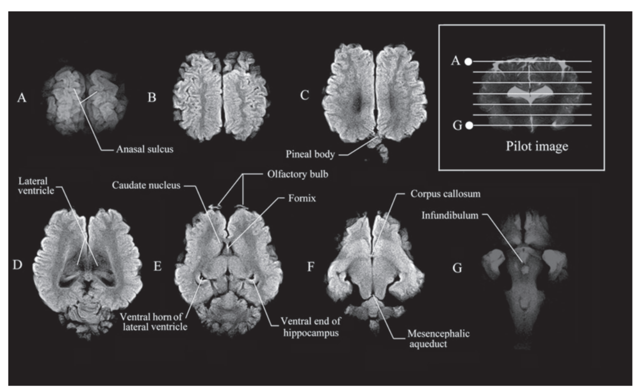

Fig 3. T1-weighted horizontal section. The pilot image shows the positions of the horizontal image slices (A-G).

thalamus, hypothalamus, hippocampus, pituitary gland, pineal body, fornix, etc.) had an intermediate signal intensity and appeared grey. The cortical grey matter was hypointense compared to white matter. The encephalic ventricular system had a reduced signal intensity.

On the T2-weighted images (Fig 1), the brain appeared dark and images were somewhat grainy. White matter of the brain appeared grey than the surrounding grey matter, and there was excellent tissue contrast. The lateral ventricle, 3rd ventricle, 4th ventricle and mesencephalic aqueduct had an intermediate signal intensity and appeared much darker.

Discussion

MRI has recently been applied to diagnosis of animals, but has greatly enhanced the ability to visualise pathologic changes. MRI has some advantages over computed tomography (CT), providing superior spatial resolution and soft tissue contrast. Several sequences are necessary to demonstrate anatomic detail and various pathologic lesions. Also, no ionising radiation is used with MRI, thus radiation hazards are avoided. The fundamental physics of MRI have been described in detail elsewhere (Laurent *et al,* 2003; Arencibia *et al,* 2005; Laurent *et al,* 2005; Kneissl *et al,* 2007).

Spin density weighted images minimised the influences of TI and T2 differences between tissues. Tissue contrast on these images depends mainly on differences in hydrogen proton concentrations in the form of free water molecules (Kraft *et al,* 1989). This is explained by the lower hydrogen proton density of white matter of the brain which appeared considerably less intense than did the grey matter, providing excellent contrast. In this study, the information presented in this paper should serve as an initial reference to evaluate MRI of the bactrian camel brain. Spin-echo T1-weighted and T2-weighted MRI of the bactrian camel brain provided an excellent detail of clinically relevant anatomy. In T1 -weighted images, delineation of normal anatomic detail was superior to T2-weighted images. A thorough understanding of normal brain anatomy on MRI is essential to optimise the diagnosis of CNS disease. As Arencibia *et al* (2000) indicated that horizonal MRI are used to evaluate the brain. Sagittal images are used to evaluate the midline structures of the CNS. The anatomic relationships of the deep cerebral structures are appreciated most easily in the transverse plane.

Two limitations of MRI that influence its usage in bactrian camel medicine are its expense and limited availability. The large size of bactrican camel currently precludes the use of MRI.

This pilot study provided an overview of the normal cross-sectional anatomy of the postmortem brain normal structures of the camel using MRI.

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