

Short communication

Magnetic resonance imaging of the normal brain in a newborn dromedary camel

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Accepted 3 June 2003

Keywords: Magnetic resonance imaging; Brain; Anatomy; Camel

Magnetic resonance imaging (MRI) has proved to be valuable in the study and evaluation of the anatomy (Goncalves-Ferreira et al., 2001) and pathology (Arnold and Matthews, 2002) of the central nervous system in human medicine. Several reports on the use of MRI in small animals have been published but these deal mostly with cranioencephalic structures (Kraft et al., 1989; Hudson et al., 1995). The use of MRI in large animal medicine is currently limited by the logistical problems of acquiring images. MRI imaging studies on the horse head have been performed on autopsy specimens (Chaffin et al., 1997; Arencibia et al., 2000), but no work has been reported on the use of MRI in camels. An accurate interpretation of the planimetric MR normal anatomy is necessary for the evaluation of pathological tissues and so the objective of the present study was to provide an overview of the normal cross-sectional anatomy of the brain and associated structures of the newborn dromedary camel using transverse MR images and gross sections.

The head of a newborn dromedary camel was refrigerated and imaged within 12 h to minimize post-mortem changes. MR imaging was performed using a superconducting magnet operating at a field strength of 1.5 T and a human head coil. Images were acquired in transverse planes with fast spin-echo sequences. T1-

weighted transverse MR images were obtained with the following parameters: repetition time (TR) = 340 ms, echo time (TE) = 8 ms, 256 × 224 matrix, 100 cm field of view (FOV), one excitation (NEX), 4 cm slice thickness with 5 cm interslice spacing. For T2-weighted transverse images, the TR was 6400 ms, TE was 105 ms, 256 × 224 matrix, 100 cm field of view, one excitation, 4 cm slice thickness with 5 cm spacing between slices. The images that most closely matched each gross section were compared with the corresponding gross anatomical sections of some head and with the literature of animal anatomy (Smuts and Bezuidenhout, 1987; Schaller, 1992; Vázquez Autón et al., 1992; De Lahunta, 1993) to identify the normal anatomy of the brain and associated structures of the head. Clinically relevant anatomic structures were identified and labeled.

The midsagittal MR image is shown in Fig. 1. Lines represent the locations of T1 and T2-weighted transverse images. Transverse MR images are shown in Figs. 2–4. The grey scale is directly related to the intensity of the signal of the brain and associated structures of the camel head. In T1-weighted images, the cranioencephalic structures (myelencephalon, pons, cerebellum, mesencephalon, cerebral hemisphere, thalamus, hypothalamus, hypophysis) and muscles of the head had a low signal intensity and appeared grey, because of a lack of tissue differentiation. The cortical grey and white matter show poor contrast due to a lack of full myelination in the neonatal dromedary. Cerebrospinal fluid (CSF) included within the encephalic ventricular system

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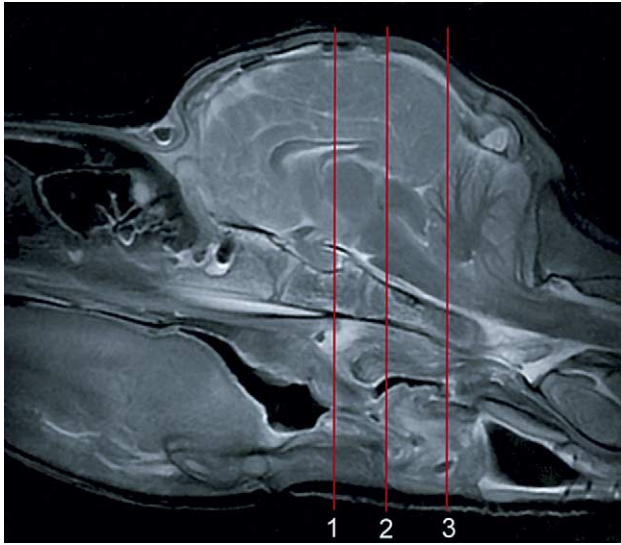


Fig. 1. Midsagittal MR image of the newborn dromedary camel head. Lines depict the transverse imaging planes.

and the subarachnoid spaces had a negligible signal intensity. The bones of the skull and ramus of mandible could be visualized indirectly because of fat in the bone marrow, as well as by observing the area of negligible signal corresponding to the cortical margins of those bones. Fat, scalp and bone marrow had a bright signal and are easily differentiated because of their high signal intensity.

The T2-weighted MR images provided excellent anatomical views of the anatomy of the brain and associate structures. Cerebral tissue has an intermediate signal intensity, so the myelencephalon, pons, cerebellum, cerebral hemispheres, hippocampus, roof of midbrain, thalamus, hypothalamus and hypophysis were easily identifiable because of their high signal intensity compared to T1-weighted MR images. T2-weighted images also show myelin in the grey matter nuclei (Counsell et al., 2002). CSF included within the encephalic ventricular system and the subarachnoid spaces had a high

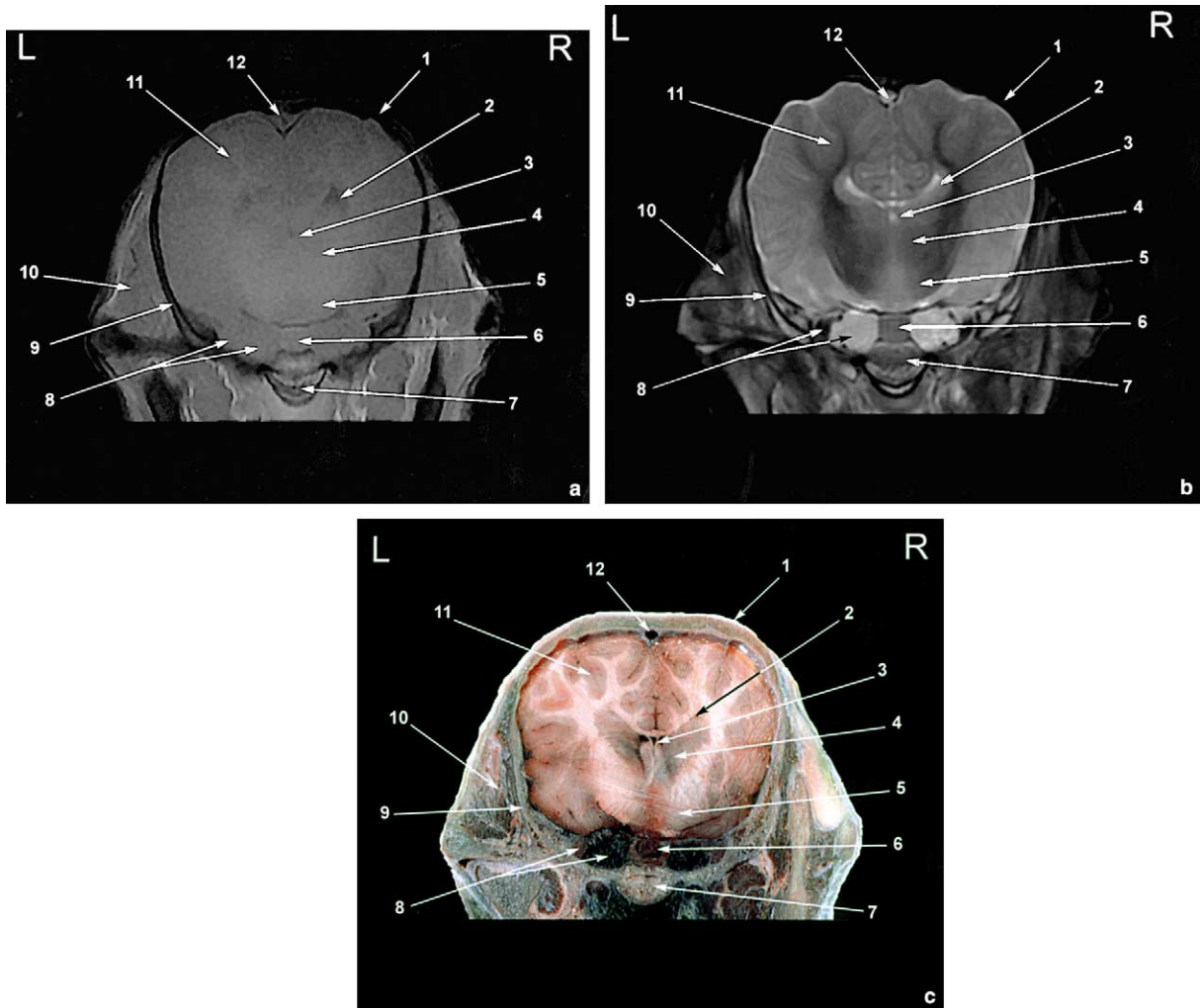


Fig. 2. (a) T1-weighted, (b) T2-weighted transverse MR images and (c) gross section at the level of pituitary gland and third ventricle (level 1). 1. Parietal bone. 2. Lateral ventricle. 3. Third ventricle. 4. Thalamus. 5. Hypothalamus. 6. Pituitary gland. 7. Body of basisphenoid bone. 8. Cavernous sinus and maxillary, trochlear, abducent and ophthalmic nerves. 9. Squamous part of temporal bone. 10. Temporal muscle. 11. Cerebral hemisphere. 12. Dorsal sagittal sinus.

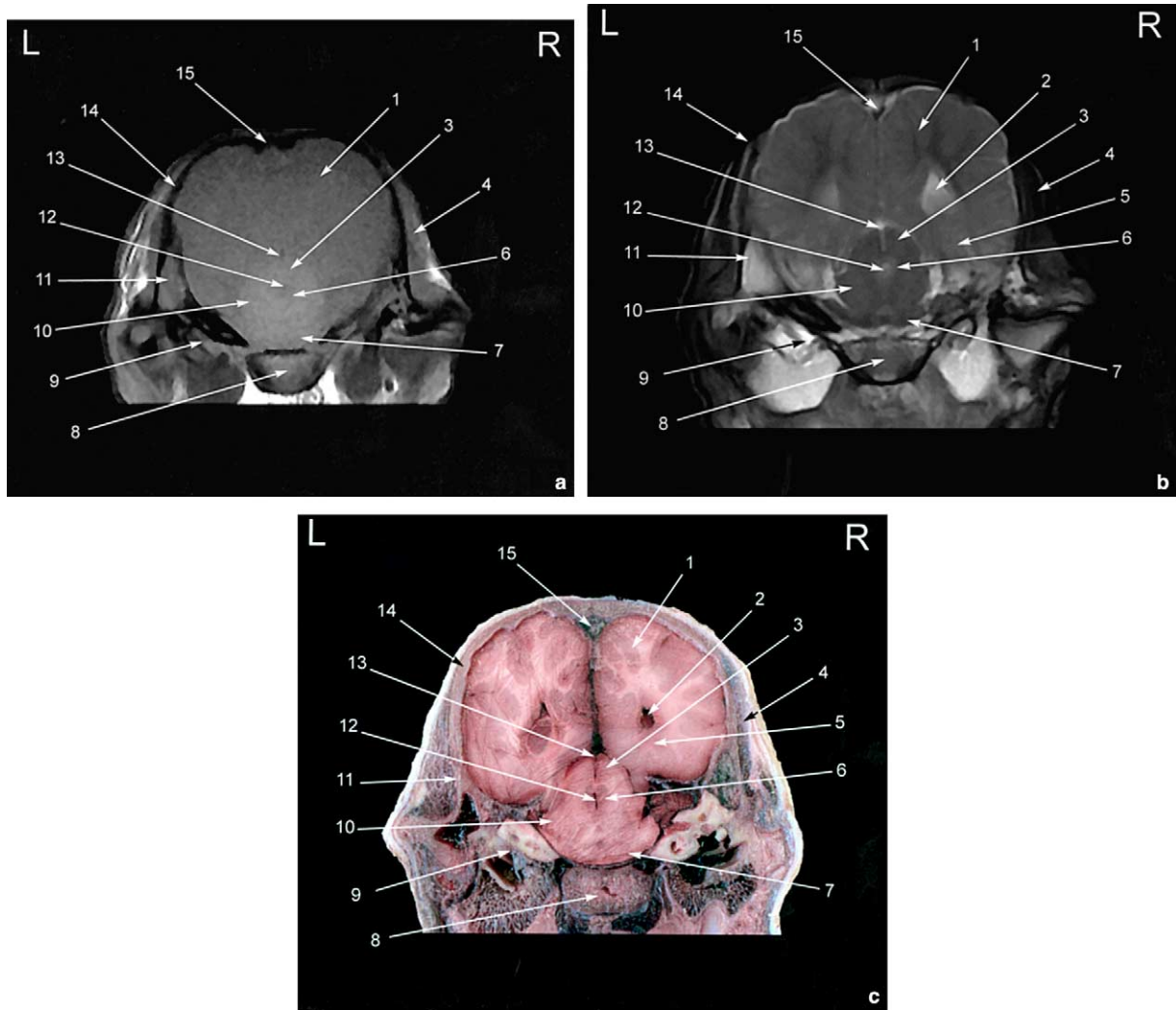


Fig. 3. (a) T1-weighted, (b) T2-weighted transverse MR images and (c) gross section at the level of cerebral peduncle and region of mesencephalic aqueduct (level 2). 1. Cerebral hemisphere. 2. Lateral ventricle (only b and c). 3. Roof of midbrain. 4. Temporal muscle. 5. Hippocampus (only b and c). 6. Central gray matter. 7. Cerebral peduncle. 8. Body of basisphenoid bone. 9. Petrous part of temporal bone. 10. Medial geniculate body. 11. Squamous part of temporal bone. 12. Region of mesencephalic aqueduct. 13. Third ventricle. 14. Parietal bone. 15. Dorsal sagittal sinus.

signal intensity and appeared bright white. The occipital, parietal, temporal, basisphenoid and presphenoid bones and mandible could be visualized indirectly because of fat in the bone marrow, as well as by observing the area of negligible signal corresponding to the cortical margins of those bones. Cortical bone, air, and rapidly flowing blood have negligible signals. Scalp, and bone marrow give have very high signal intensity.

Clinical diagnosis by imaging techniques is based on different physical principles that allow visualisation of the internal structure, composition and function. MR is based on the properties of certain elements, mainly hydrogen, to send a radiofrequency signal when it is under a magnetic field of a certain intensity stimulated by radiowaves at an appropriate frequency. Advantages of MRI include multiplanar imaging, superior contrast resolution and the absence of ionizing radiation (Shores, 1993).

Spin-echo T1 and T2-weighted MR images of the camel head have provided details of clinically relevant anatomy and there was discrimination of both soft and mineralized tissues. The progression of myelination was apparent and conventional T1-weighted pulse sequences revealed the conversion of white matter regions from low to high intensity signal consistent with deposition of myelin (Barnes and Wolpert, 1992). T2-weighted fast spin-echo MR imaging showed the myelin in grey matter nuclei.

A thorough understanding of normal brain anatomy on MR images is essential to optimize the diagnosis of central nervous system disease (Stewart et al., 1992; Dennis, 1995), but magnetic resonance imaging techniques are powerful tools for the investigation of neurodevelopment (Rivkin, 2000). The use of MRI in camel medicine is practically limited because of expense and the low availability of a suitable unit and a

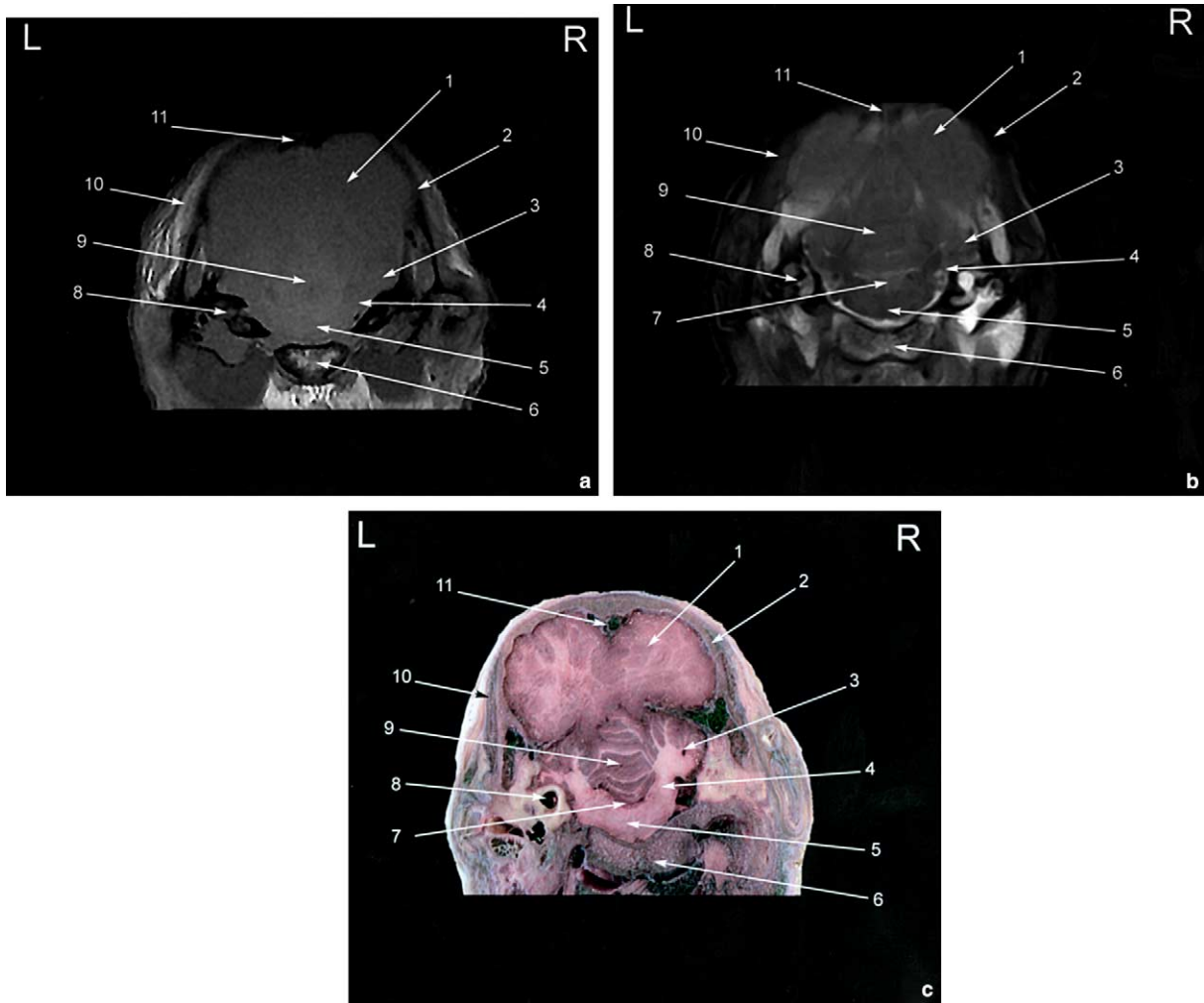


Fig. 4. (a) T1-weighted, (b) T2-weighted transverse MR images and (c) gross section at the level of myelencephalon and fourth ventricle (level 3). 1. Cerebral hemisphere. 2. Parietal bone. 3. Cerebellar hemisphere. 4. Cerebellar peduncle. 5. Myelencephalon. 6. Basilar part of occipital bone. 7. Fourth ventricle. (only b and c). 8. Petrous part of temporal bone. 9. Cerebellar vermis. 10. Temporal muscle. 11. Dorsal sagittal sinus.

non-magnetic anaesthetic unit. Nevertheless, these images should provide useful reference material for further future clinical studies of camels' heads.

Acknowledgements

The authors thank the Special Diagnostic Service of San Roque Clinic of Las Palmas de Gran Canaria (Spain).

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