Imaging Characteristics and Treatment of a Penetrating Brain Injury Caused by an Oropharyngeal Foreign Body in a Dog

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Key words: magnetic resonance imaging, computed tomography, canine.

Running head: Oropharyngeal foreign body penetrating the brain.

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Abstract:

A four-year-old Border collie was presented with one episode of collapse, altered mentation, and a suspected pharyngeal stick injury. Magnetic resonance imaging (MRI) and computed tomography showed a linear foreign body penetrating the right oropharynx, through the foramen ovale and the brain parenchyma. The foreign body was surgically removed and medical treatment initiated. Complete resolution of clinical signs was noted at recheck eight weeks later. Repeat MRI showed chronic secondary changes in the brain parenchyma. To the authors' knowledge, this is the first report of the advanced imaging findings and successful treatment of a penetrating oropharyngeal intracranial foreign body in a dog.

Signalment, history and clinical findings:

A four-year-old, male neutered, Border collie dog was presented for investigations of a suspected pharyngeal foreign body. The owner reported that the dog had eaten something ten days prior to presentation, and he immediately vomited it and yelped. Thereafter the dog showed intermittent lethargy, inappetance, retching, dysphonia and more recently changes in mentation and behaviour, and an episode of collapse. The general physical examination was unremarkable, except from a focal area of erythema on the soft palate at oral examination. Neurological examination showed intermittent altered mentation, absent menace response in the left eye and inconsistent proprioceptive ataxia affecting all limbs. Ophthalmological examination was unremarkable. Neuro-anatomical localisation was therefore the right forebrain. Complete blood cell count and biochemistry did not reveal any significant abnormalities. The main differential diagnosis based on the history and clinical findings was a foreign body penetrating from the oropharynx into the brain.

Imaging, diagnosis and outcome:

Computed tomography (CT) of the brain was performed using a dual-slice scanner (Siemens Dual Slice Somatom Spirit, Siemens AG, Arlangen, Germany). Images were reformatted using bone and soft tissue algorithms and were acquired using the following acquisition parameters: 130 kVp, 66-74 mA, 512 × 512 matrix dimension, 2mm slice thickness, 164 mm field of view. A linear hyperattenuating structure (130-150 Hounsfield units) compared to normal gray matter was appreciated perpendicular to the right basisphenoid bone, just rostral to the right tympanic bulla. The object could be seen passing through the right foramen ovale and into the right neuro-cranium (Fig. 1D). The object measured approximately 5.5cm in length. No obvious CT changes to indicate cerebral parenchymal hemorrhage were noted.

Given the lack of metallic artifact and appearance on CT, it was deemed safe to proceed with magnetic resonance imaging (MRI).

Magnetic resonance imaging of the brain was performed using a high-field scanner (1.5-Tesla unit, Siemens Magnetom Essenza; Frimley, UK). No contrast was administered. Images were acquired in transverse, sagittal, and dorsal planes. Repetition time and echo time were 530-560 and 12-14 ms (T1-weighted), 3590–4801 and 85-97 ms (T2-weighted), 477 and 12ms (T2*), or 5900 and 118 ms (fluid attenuated inversion recovery, T2-FLAIR). Slice thickness was 3.5-4 mm, with a 0.5 mm interslice gap. Field of view was 12–16 cm. All intensities were compared to normal gray matter. The same 5.5cm long hypointense linear structure was seen running vertically on the right side (Fig. 1A-C and Fig. 2A). A diffuse T2W hyperintensity was present throughout the white matter in the surrounding area involving the right parietal, frontal and temporal lobes. In the right ventral temporal lobe there was a round structure with a diffusely T2W hyperintense and T1W hypointense signal consistent with fluid. Mass effect was present with a midline shift to the left. On T2* images there was an area of signal void in the right temporal lobe indicating hemorrhage. There was evidence of papilledema in the right globe, increased intracranial pressure, cerebellar herniation with possible secondary syrinx formation in the cranial cervical spinal cord.

The foreign body was surgically removed using a simple intra-oral retrograde approach. A small incision in the soft palate and the tip was grabbed with a pair of forceps and gentle traction was applied. The foreign body was successfully removed in one piece and was confirmed to be a wooden cocktail stick, this was sent for bacterial culture and sensitivity, later isolating *Pasturella Multocida* and *Fusobacterium spp.*

Immediately after surgical removal of the foreign body, an MRI scan was repeated. A tract remained circumscribing the area inhabited by the penetrating foreign body (Fig. 2B).

Previous noted areas of hemorrhage were static in appearance with no evidence of intra- or post-operative hemorrhage.

The dog remained hospitalised for two days for observation. Treatment included intravenous fluid therapy at maintenance rates, Hartmann's (Vetivex 11, Dechra, UK); cefuroxime 20mg/kg IV TID (Zinacef ®, Glaxo Operations UK Ltd, UK), metronidazole 10mg/kg IV BID (Metronidazole, Baxter Healthcare Ltd, UK), enrofloxacin 5mg/kg IV SID (Baytril ®, Bayer plc, UK); dexamethasone 0.16mg/kg IV SID (Dexadreson ®, Intervet UK Ltd, UK); and levetiracetam 30mg/kg IV TID (Keppra®, UCB Pharma S.A., Belgium). The day after foreign body removal the dog's ataxia was more pronounced and the right pupil miotic, this improved over the subsequent 48 hours. The dog was discharged showing only very mild ambulatory ataxia, the remainder of the neurological examination was normal. Oral medications implemented were levetiracetam 30mg/kg PO TID long term (Keppra ®, UCB Pharma S.A., Belgium), enrofloxacin 6mg/kg PO SID for seven days (Baytril ®, Bayer plc, UK), cephalexin 20mg/kg PO BID for seven days (Cephacare ®, Animalcare Ltd, UK), metronidazole 12mg/kg PO BID for seven days (Metronidazole, Millpledge Veterinary, UK), and a tapering prednisolone regime of 0.4mg/kg PO SID for 5 days; 0.2mg/kg PO for 5 days; 0.2mg/kg EOD and then discontinued (Prednidale®, Dechra, UK).

The dog re-presented eight weeks later for a scheduled re-check and repeat MRI. The owner reported that the dog had been clinically well, with the mild ataxia having resolved since discharge. MRI showed near resolution of the appearance of the previous foreign body tract. Marked T2W and FLAIR hyperintensity remained and was confined to the dorsal half of the right cerebral hemisphere (Fig. 3). A cyst-like structure was noted ventral to the right lateral ventricle, which was hypointense on FLAIR, supporting cerebral spinal fluid accumulation. It was suspected to be a diverticulum from the ventricle secondary to trauma from the foreign body. Evidence of increased intracranial pressure was no longer noted. Contrast was administered at 0.1ml/kg IV (Gadovist 1.0 mmol/ml; Bayer, Berkshire UK) and no abnormalities were noted. Overall there was marked improvement in traumatic brain changes compared to previous scan. At this time, a cisternal cerebrospinal fluid sample was taken which was normal. The dog was discharged with levetiracetam at the same dose to continue. To the date of writing, the dog is reported to be clinically well and the levetiracetam dose decreased (5 months post discharge), with the aim of discontinuation.

Discussion

Intracranial foreign bodies are uncommonly reported in the veterinary literature.[1-8] Similarly to the case reported here, they displayed progressive and variable neurological deficits reflecting the location of the lesion. Previous successful treatment has been reported just in one cat with no confirmation of brain parenchyma penetration.[3] Imaging modalities used varied from either radiography, CT or MRI, with diagnoses confirmed at post-mortem in the majority of cases. The case reported here details a combined imaging approach (CT and MRI) and a follow up MRI to assess chronic sequelae. Location of entry was identified to have been via the foramen ovale. Interestingly penetration to the neuro-cranium trough the foramen ovale was suspected in a previous report.[1] As the mandibular branch of the trigeminal nerve runs through the foramen ovale, injury of this branch by the foreign body would be a concern, however, clinically it appeared unaffected. In humans, intracranial penetrating foreign bodies are relatively uncommon accounting for only 0.4% of all head injuries.[9-13]

The bacteria isolated from culture of the cocktail stick in this case included *Pasturella Multocida* and *Fusobacterium* spp., consistent with previous reports of bacterial meningoencephalomyelitis.[14]

Initial CT images allowed the foreign body's composition to be assessed prior to MRI scan. It was suspected to be a wooden foreign body due to the lack of metallic artefact, and an attenuation of 130-180 HU, however wooden foreign bodies can display variable attenuation dependant on chronicity.[15] MRI showed changes to the right side of the brain, which stimulated the decision to repeat an intraoperative mannitol bolus. Imaging findings aided in surgical planning, showing that the foreign body was more accessible from the oral cavity than from a craniotomy approach. Post removal MRI was useful showing no evidence of intra or post-operative hemorrhage and concluding that the foreign body had been removed in its entirety with minimal further trauma to the brain.

In acute presentations of penetrating brain injuries in the human cases, initial imaging modality consists of CT with three dimensional reconstruction to assess the trajectory and position of the foreign body, and cerebral angiogram to demonstrate major blood vessel damage.[11,13] This database allows for surgical planning.[10-13]

In human medicine, CT is highlighted as the most valuable imaging modality for initial assessment of foreign objects, however limitations exist where the foreign bodies are made of wood or plastic, and in these cases MRI may be superior.[12,13,16] The main neuro-imaging negative prognostic indicators in humans are: the presence of a missile track; evidence of increased intracranial pressure; and presence of hemorrhage or mass lesion. [17-18] MRI assessment remains superior for evaluation of brain tissue. However, again the limitations of MRI have to be considered in the immediate phase (lengthy, contra-indicated where ferromagnetic foreign bodies present and incompatible with some monitoring equipment), hence it is deemed more useful in the sub-acute phase (48-72h post-injury) where it is important to assess secondary brain injuries that essentially predict prognosis.[19,20]

Repeat imaging in this case was performed eight weeks post removal of the foreign body and showed marked improvement in traumatic brain changes and resolution of signs of increased intracranial pressures. However, marked right-sided white matter oedema remained. This was suspected to be a slowly improving injury and potentially associated with ischemia due to the original injury. Repeat imaging in post surgical human cases of intracranial penetrating foreign bodies is performed, however is targeted at vascular assessment as these complications are significant.[13]

In contrast to the majority of previously reported penetrating intracranial foreign bodies in the veterinary literature,[1,2,4,5,6,7] this case reports a good outcome. Prophylactic anti-epileptic medication was implemented in the present case, with no immediate or late reports of seizure activity. Anti-epileptic medication is prescribed prophylactically only for the first seven days in humans as it has been shown only to prevent the incidence of early and not late seizure development, however longer courses have been prescribed where there has been extensive oedema and brain tissue damage.[13]

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Figure legends

Fig 1: (A) Transverse T2-weighted image, (B)Transverse T1-weighted image, (C)Transverse T2* image and (D) transverse CT image (soft tissue window) at the level of the temporo-mandibular joint. The foreign body can be seen as a linear hypointense/hyperattenuating structure (arrows) running through the right foramen ovale and into the right cerebral hemisphere. T2-weighted hyperintensity can be appreciated in the white matter of the right cerebral hemisphere (A).

Fig 2: (A) Initial T2-weighted parasagittal image and (B) immediate post-operative T2-weighted parasagittal image. Post-operative image (B) indicates the linear foreign body was removed in its entirety and an obvious tract can be appreciated in its previous location.

Fig 3: Follow up MRI images obtained eight weeks following removal of foreign body. (A) T2-weighted transverse image, (B) T1-weighted transverse image, (C) Fluid attenuation inversion recovery (FLAIR) sequence at the level of caudate nuclei. The foreign body tract is no longer appreciated. T2W white matter hyperintensity in the dorsal right cerebral hemisphere remains (A). Corresponding hyperintensity on FLAIR(C) in this region (arrow) supports presence of oedema. A cyst like structure(asterix) can be see ventral to the right ventricle.