Successful Nonsurgical Management of a Traumatic Dens Fracture in a Cat with Clinical and Radiographic Resolution

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ABSTRACT

An adult domestic shorthair presented with obtundation, vestibular ataxia, head tilt, and visible evidence of facial injury following motor vehicle trauma. Plain radiographs and computed tomography imaging revealed a complete minimally displaced transverse fracture of the caudal aspect of the dens of the C2 vertebra and multiple minimally displaced cranial fractures. The dens fracture was managed with 8 wk of strict rest, followed by 4 wk of supervised activity at home. No external immobilization was performed. Neurological examinations at 8 days, 10 wk, and 9 mo following initial presentation were normal. Repeat radiographic and computed tomography examinations at 10 wk and 9 mo following the traumatic event demonstrated progressive and eventual complete osseous union of the fractured dens. To the authors' knowledge, this is the first report of successful nonsurgical management of a traumatic dens fracture in an adult cat with documented radiographic and clinical resolution. This report suggests that nonsurgical management can be considered in such cats and that complete resolution with osseous union is feasible. (*J Am Anim Hosp Assoc* 2022; 58:48–53. DOI 10.5326/JAAHA-MS-7192)

Introduction

The dens (odontoid process) is an osseous eminence originating from the cranioventral surface of the second cervical vertebrae (axis). It lies dorsal to the ventral surface of the vertebral canal of the first cervical vertebra (atlas) and forms part of the atlantoaxial joint. Ligamentous attachments of the dens are the apical ligament and the alar ligaments. They originate from the basioccipital and occipital bone and insert on the apex of the dens and on either side of the apical ligament, respectively. The transverse ligament crosses the dens dorsally and functions to hold the dens against the ventral aspect of the vertebral canal of the atlas.[1] The dens is integral to the normal biomechanics of the atlantoaxial joint, and injury to this region can cause atlantoaxial instability.[2]

In veterinary and human literature, axis fractures are most commonly due to motor vehicle trauma.[3,4] Although fractures of the axis account for approximately half of all cervical fractures in dogs, fractures involving the dens are infrequently encountered.[4–6] Traumatic axis fractures in cats are less well described. One case report describes displacement of the dens (of unknown etiology) in a juvenile cat, which was managed nonsurgically without external immobilization. Subsequent radiographs revealed no signs of healing.[7]

To the authors' knowledge, nonsurgical management of a confirmed traumatic dens fracture in a cat, with long-term outcome, including the use of computed tomography (CT) to document radiographic union, has not been previously reported. This case report describes the nonsurgical management as well as clinical and radiographic progression of an adult cat with a traumatic dens fracture.

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CT (computed tomography); PLR (pupillary light reflex); RI (reference interval)

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Case Report

A 3 yr 5 mo old neutered male domestic shorthair was presented to our hospital following motor vehicle trauma the previous day. The cat had no significant previous medical history. On presentation, the heart rate was 180 bpm, the respiratory rate was 20 breaths/min, the peripheral pulse quality was good, and the indirect Doppler blood pressure measurement was 120 mm Hg. Body weight was 4.9 kg with a body condition score of 5/9. Marked facial swelling and bilateral sanguineous nasal discharge was present. There was exophthalmos and mydriasis of the left eye, which could not be retropulsed. The right eye was unremarkable. An open mandibular symphyseal fracture was present, as well as a crown fracture of tooth 204. Dental occlusion was poor with caudolateral translation of the left hemimandible. The cat appeared painful on palpation of the face. Moderate obtundation, a subtle right-sided head tilt, and ambulatory ataxia affecting all four limbs with falling and leaning to the right were noted. Ocular examination was performed by a board-certified ophthalmologist. Menace response, dazzle reflex, and direct pupillary light reflex (PLR) were absent in the left eye, with an absent indirect PLR to the right eye. Menace response, dazzle reflex, and direct PLR were present in the right eye, with an absent indirect PLR to the left eye. Corneal sensation was absent in the left eye but present in the right. Neck manipulation and spinal palpation were not carried out given the risk of vertebral column instability. The rest of the neurological examination was unremarkable. These neurological abnormalities gave a multifocal localization of right-sided vestibular system (suspected central, could not exclude cranial cervical spinovestibular tract involvement), left parasympathetic oculomotor nerve, left ophthalmic branch of the trigeminal nerve, and left retina or optic nerve. Neurological examinations were carried out by a board-certified neurologist or a neurology resident supervised by a board-certified neurologist. Orthopedic examination was carried out by a board-certified surgeon and was unremarkable, aside from the facial injuries previously described.

Venous blood gas, electrolyte, and metabolite analysis revealed the following abnormalities: pH 7.261 (reference interval [RI] 7.350 − 7.470), hypernatremia (153 mmol/L, RI 140 − 153 mmol/L), hyperchloremia (121 mmol/L, RI 106 − 120 mmol/L), and hyperglycemia (7.8 mmol/L, RI 4.7 − 7.3 mmol/L).

Initial treatment consisted of methadone[a] (0.1 mg/kg IV *q* 4 hr), IV fluid therapy (2 mL/kg/hr compound sodium lactate[b]), amoxycillin-clavulanate[c] (20 mg/kg IV *q* 8 hr), oxygen supplementation, and eye lubrication[d] (*q* 1 hr).

The cat was anaesthetized for imaging using methadone[a] premedication (0.2 mg/kg IV), propofol[e] induction agent (4 mg/kg IV), and isoflurane[f] in oxygen for maintenance following endotracheal intubation. Induction was performed in lateral recumbency with minimal neck manipulation.

The cat was positioned in right lateral recumbency, and whole-body CT was performed using an 80-slice helical scanner.[g] Acquisition parameters were as follows: 120 kVp, 208 − 250 mA, 512 × 512 matrix dimension, 0.5 mm slice thickness. IV injection of iohexol[h] (2 mL/kg) was administered, and image acquisition was repeated as above. Images were reformatted using bone and soft-tissue algorithms.

CT revealed a complete transverse fracture of the caudal aspect of the dens, with minimal (<1.0 mm) displacement (**Figures 1A–C**). Additional abnormalities included bilateral fractures of the nasal bone involving the medial wall of both orbits and pterygoid processes ventrally, a hard palate fracture, and bilateral zygomatic arch fractures. There was retrobulbar soft-tissue attenuating material consistent with a hematoma on the left side without evidence of globe rupture. There was a complete, transverse fracture of the medial left mandibular condyle, a mandibular symphyseal fracture, and a fracture of the crown of tooth 204. No further abnormalities were noted, including no middle, inner ear, or intracranial abnormalities.

Upon identification of the dens fracture, the cat was secured to a rigid board in lateral recumbency under anesthesia by placing adhesive tape[i] over the head, shoulders, and pelvic region. Dynamic flexion studies to evaluate fracture stability were not performed because of concerns that excessive neck manipulation could exacerbate any spinal cord injury. A circumferential intermandibular wire was placed routinely in order to reduce and stabilize the mandibular symphyseal separation, resolving the malocclusion. Routine left-sided esophagostomy tube placement was performed. Procedures were performed with care in the same lateral recumbency to ensure minimal movement of the neck. A right lateral radiograph was obtained to confirm appropriate esophagostomy tube placement (**Figure 2**), in which the dens fracture was also visible.

The adhesive tape[i] was removed once the cat had recovered from anesthesia. The cat was kept strictly cage confined for the duration of hospitalization. External rigid immobilization of the neck was not applied. A padded cloth collar[j] was placed to protect the esophagostomy tube site. Esophagostomy tube feeding was initiated once the cat had recovered from anesthesia.

The cat was maintained on IV fluid therapy (2 mL/kg/hr IV compound sodium lactate[b]), methadone[a] (0.1 − 0.2 mg/kg IV *q* 4 hr), amoxycillin clavulanate[c] (20 mg/kg IV *q* 8 hr), and eye lubrication[d] (*q* 1 hr) until the third day of hospitalization, after which buprenorphine[k] (0.01 − 0.02 mg/kg IV *q* 6 − 8 hr) and oral amoxycillin clavulanate[l] (13.6 mg/kg *q* 12 hr) were administered. Eye lubrication[d] (*q* 1 hr) was continued.

Neurological examination on day three of hospitalization was unchanged compared with initial presentation, with no evidence of

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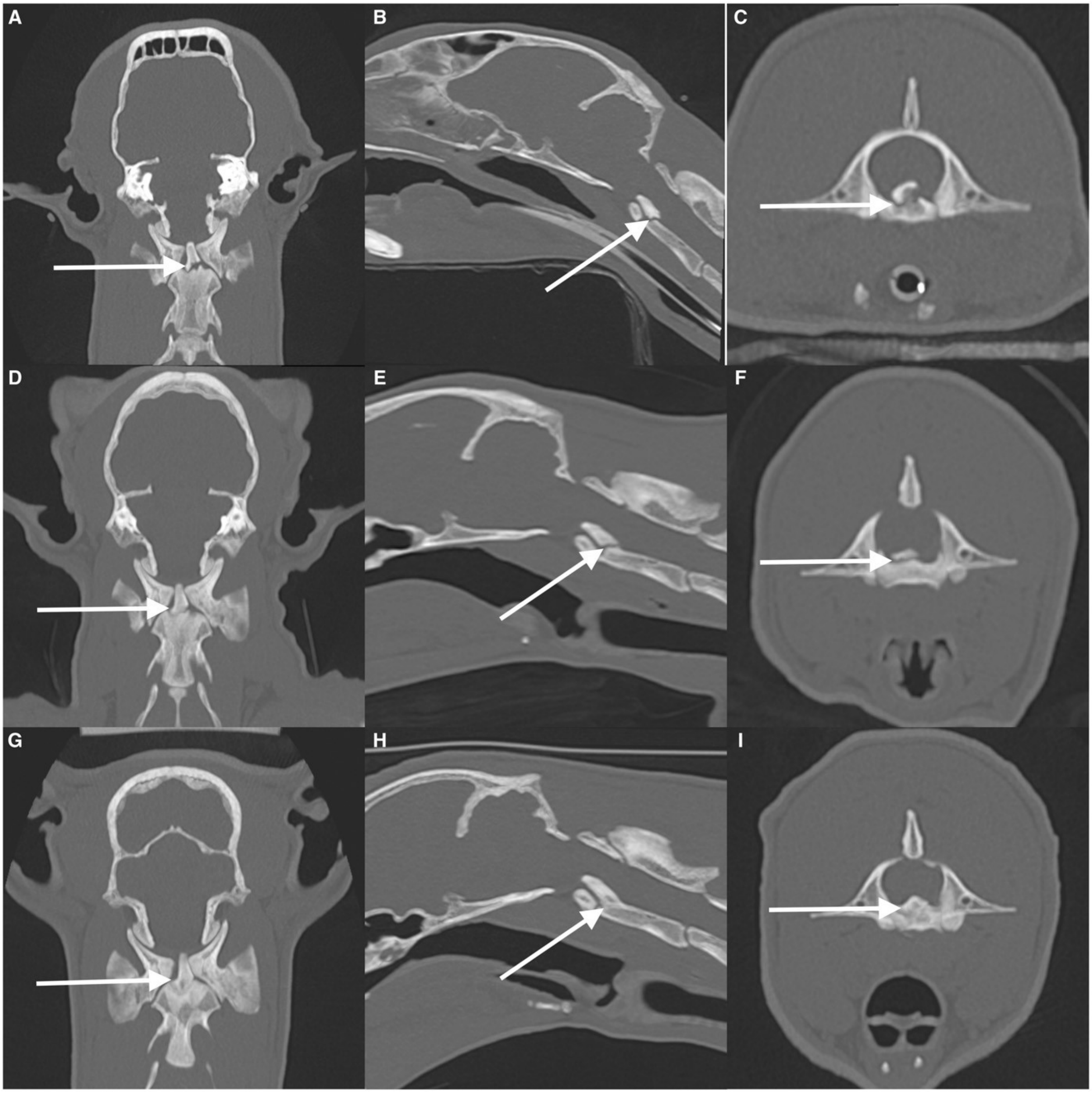

FIGURE 1

Dorsal (left column), *sagittal* (middle column), *and transverse* (right column) *computed tomography reconstructions showing progression of traumatic dens fracture* (arrow) *in an adult cat 2 days* (A, B, C), *10 wk* (D, E, F) *and 9 mo* (G, H, I) *after trauma. In the earliest series of images, the fracture is identified as a sharply marginated, transverse, irregular hypoattenuating line at the base of the dens. The dens is minimally displaced relative to the vertebral body of the axis. In the second series, the fracture margins are less sharply demarcated, and smooth osteoproliferation is visible bridging from the caudodorsal aspect of the dens to the craniodorsal aspect of the vertebral body of the axis. In the final series, complete osseous union of the dens fracture is evident.*

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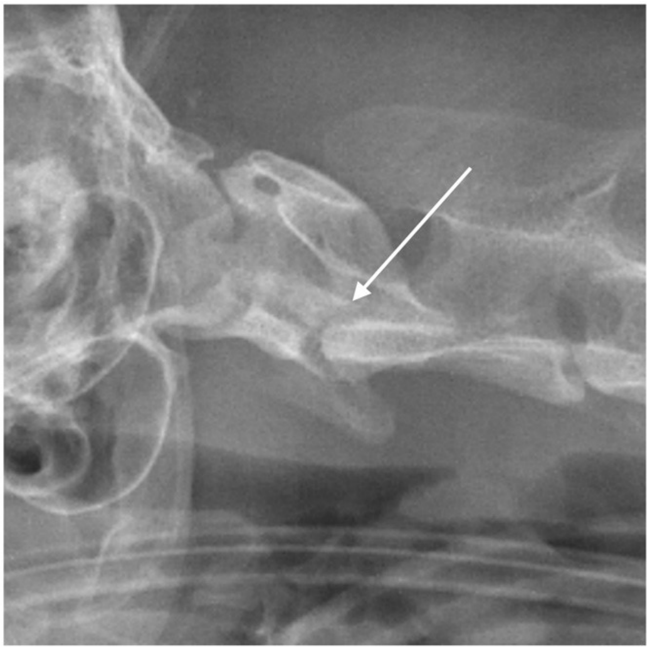

FIGURE 2
Right lateral radiograph showing a minimally displaced traumatic fracture (white arrow) *of the base of the dens in an adult cat 2 days after trauma. This image is comparable to the sagittal computed tomography reconstruction presented in Figure 1B, illustrating the potential utility of radiography to diagnose fractures of the dens.*

pain or restricted voluntary movement of the neck. By day eight of hospitalization, the head tilt had resolved, and only mild generalized vestibular ataxia alongside the left ocular deficits remained, at which point the cat was discharged. The cat was discharged with instructions to complete the 10 day course of oral amoxicillin clavulanate[l] (13.6 mg/kg *q* 12 hr) and meloxicam[m] (0.05 mg/kg once daily). Instructions for esophagostomy tube management, eye lubrication[n] (*q* 12 hr), and strict crate rest for 8 wk with no handling of the neck region were also emphasized.

The cat was re-presented 10 wk after injury. For the first 8 wk, the cat had remained strictly confined, and then for 2 wk before presentation the cat was allowed supervised access to a small room for between 1 and 8 hr with no opportunity for high-impact activity. Repeat examination revealed acceptable dental occlusion. Examination of the left eye remained unchanged, as assessed by repeat ophthalmological examination as described earlier. Neurological examination was unremarkable. The esophagostomy tube had been removed at the primary care veterinary practice.

The cat was sedated using medetomidine[o] (0.01 mg/kg intramuscularly) and butorphanol[p] (0.2 mg/kg intramuscularly) and was positioned in sternal recumbency. CT was performed as detailed above, without contrast administration, and the intermandibular wire was removed. The mandibular symphysis was stable following wire removal. The dens remained unchanged in position with a fracture line still evident at its base. Smooth bridging osteoproliferation was visible at the dorsal aspect of the fracture site (Figures 1 D–F). The zygomatic arch and mandibular condyloid fractures were still present. The hard palate and mandibular symphyseal fractures had healed.

The cat was discharged with instructions for continued left eye lubrication[n] (*q* 12 hr), house confinement for a further 4 wk, and to minimize excessive activity. Following an owner telephone interview 4 wk later, activity restriction was lifted.

At re-examination 9 mo after injury, the cat was clinically normal at home and not receiving any medications. Aside from the nonvisual left eye, physical and neurological examinations were unremarkable, and the cat was sedated using the previous protocol for CT scan. The dens was similarly positioned, and osseous union with the craniodorsal aspect of the vertebral body of the axis was present (Figures 1 G–I). The left and right zygomatic arch fragments were still present, with less clearly defined fracture lines. The left mandibular condyloid fragment was not visible. The previous nasal bone fractures were not present but slight malalignment was appreciable. The cat was discharged for ongoing monitoring for any signs of corneal ulceration, pain, or neurological deterioration.

Discussion

This case report is the first complete description of the successful management of a traumatic dens fracture in an adult cat with radiographic confirmation of osseous union and long-term outcome. Although fractures of the dens, axis, and traumatic atlantoaxial subluxation are often managed surgically, the majority of reported cases involve dogs.[4,6] Our findings demonstrate that nonsurgical management of a dens fracture in a cat is feasible and that complete osseous union can occur without surgical stabilization.

In people, several classification systems describing fractures of the axis have been developed on which treatment recommendations can be based.[8,9] A recent publication by Schmidli et al. evaluated fractures of the axis in 66 dogs and 3 cats using a modification of the human Anderson and D'Alonzo classification system, as follows: type I describes a fracture line running through the tip of the dens, type II running through the base of the dens, and type III running through the body of the axis.[4,9] Using this modified classification system, the cat in our case report represents an example of a type II axis fracture. Of the three feline cases of axis fractures described in the study by Schmidli et al., two suffered vertebral body fractures (type III) and one suffered fracture to the tip of the dens (type I).

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No cats with type II fractures were described, and management and outcome in the feline cases were not separately described.[4]

People with dens fractures may not achieve osseous fracture union when managed nonsurgically. Treatment recommendations for humans suffering type II dens fractures typically entail external immobilization, and nonunion rates of 26 − 47% are reported.[3,11,12] Surgery is typically reserved for people with ≥6 mm displacement, instability despite external coaptation, or transverse ligament disruption.[3] Susceptibility of type II dens fractures to nonunion is theorized to be due to poor vascular supply and traction from the apical ligament.[13] Demonstration of complete osseous union of a feline dens fracture with nonsurgical management in our report is therefore of interest. Although our findings suggest that nonsurgical management is a feasible option in cats with traumatic dens fracture, further investigation with a greater numbers of cats is required to confirm the optimal treatment.

Surgical management of dogs with cervical fractures has been associated with a mortality rate of 35 − 40%.[5,14] Although similar data are not available for cats, the risks are considered likely to be comparable. Accordingly, surgical management of cervical vertebral fractures in dogs and cats is typically reserved for animals that are tetraplegic or that have reduced ventilatory ability, demonstrate progressive neurological deterioration despite confinement, or remain markedly painful despite appropriate management.[15] The study by Schmidli et al. included nine type II axis fractures in dogs. Seven of those cases were managed surgically, and two were managed nonsurgically, both of which made a partial recovery.

Successful nonsurgical management of cervical fractures has been reported in dogs and cats previously, using either external coaptation or cage rest alone.[4,5,7,16] External coaptation options in dogs and cats with vertebral fractures include casting and splinting, although these techniques can be associated with loosening, skin abrasions, discomfort, and poor patient tolerance, particularly in cats.[5,17,18] Cranial cervical vertebral fractures are difficult to immobilize because there is limited space for rostral support and the dressing needs to be sufficiently tight without occluding vascular or respiratory systems.[18]

Given the challenges of cervical immobilization, the cat's stable neurological status, and comfort, the authors opted against external immobilization. Similarly, because of the anticipated risks associated with surgical stabilization, including narrow safe corridors for implant placement because of patient size, vertebral size necessitating relatively weak implants, and the previously reported high perioperative mortality rate, the decision was made not to pursue surgical stabilization in this case.[5] The mild degree of fracture displacement may have contributed to the good outcome in this case and could be a consideration when electing for surgical or nonsurgical management in such cases. A more significant displacement of fracture fragments might influence decision making, and further studies regarding management of these cases are required. It is notable that the magnitude of displacement is the most important factor for success in dens fractures managed nonsurgically in humans. Radiographic evidence of osseous union and clinical improvement over the 9 mo of follow-up supports the nonsurgical approach in this case.

This case also emphasizes the importance of careful handling and thorough investigation of cats with traumatic injury. Initial neurological examination findings were largely consistent with the multiple cranial fractures and ocular trauma evident, with the obtundation most likely representing a brainstem or bilateral forebrain localization consistent with mild traumatic brain injury. As a result, the right-sided vestibular signs may have reflected a central vestibular syndrome related to brainstem dysfunction. However, it is also possible that they may have been caused by the fractured dens causing a lateralized injury to the spinovestibular tracts that pass through the first three cervical spinal cord segments.[19] Care should therefore be taken when interpreting neurological examination findings in cats following head trauma. MRI of the head and cervical spine could have been performed to further support this localization. This was not performed because of financial constraints and the likelihood that the management would not have altered. However, a recent study suggested that specific MRI findings may have prognostic use in cats with signs of traumatic brain injury and could therefore be of use in more severely affected patients.[20]

Aside from the vestibular dysfunction that could be related to spinovestibular tract injury, there were minimal clinical signs to indicate a cervical vertebral fracture. This is likely the result of the relatively large volume of the cervical vertebral canal relative to the spinal cord, along with the minimal displacement of the dens fragment.[1,15] Given the high rate of vertebral fractures in cases of blunt trauma and the potential for multiple axial skeletal fractures, this case report further supports the use of whole-body CT in similar clinical scenarios.[18]

This report describes the first radiographically documented osseous union of a traumatic dens fracture in an adult cat using CT imaging, as well as complete resolution of clinical signs. There is a sparsity of literature regarding this injury in cats, and the optimum treatment recommendation remains unclear, although nonsurgical management was successful in this instance. Clinicians should remain cognizant of this type of injury, particularly in cats presenting with other signs of cranial trauma.

FOOTNOTES

[a] Comfortan; Dechra Veterinary Products, Shrewsbury, Shropshire, United Kingdom

[b] Vetivex 11 (Hartmann's); Dechra Veterinary Products, Shrewsbury, Shropshire, United Kingdom

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[c] Co-amoxiclav; Bowmed Ibisqus, Chirk, Wrexham, United Kingdom
[d] UK Celluvisc 1.0%; Allergan, Marlow, Buckinghamshire, United Kingdom
[e] PropoFlo Plus; Zoetis UK, Ltd., Leatherhead, Surrey, United Kingdom
[f] IsoFlo; Zoetis UK, Ltd., Leatherhead, Surrey, United Kingdom
[g] Aquilion ONE Model TSX-305A; Canon Medical Systems Europe, Zoetermeer, the Netherlands
[h] Omnipaque 300; GE Healthcare, Chicago, Illinois
[i] Strappal; BSN Medical, Hull, Yorkshire, United Kingdom
[j] Kitty Kollar; Veterinary Instrumentation, Sheffield, United Kingdom
[k] Buprecare; Animalcare, Ltd., York, Yorkshire, United Kingdom
[l] Kesium; Ceva Animal Health, Ltd., Amersham, Buckinghamshire, United Kingdom
[m] Metacam; Boehringer Ingelheim Animal Health UK, Ltd., Bracknell, Berkshire, United Kingdom
[n] Artelac Nighttime Gel; Bausch & Lomb, Kingston upon Thames, Surrey, United Kingdom
[o] Sedastart; Animalcare, Ltd., York, Yorkshire, United Kingdom
[p] Torbugesic; Zoetis UK, Ltd., Leatherhead, Surrey, United Kingdom

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