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What Is Your Neurologic Diagnosis?

A 3-year-old 16.2-kg sexually intact female Cocker Spaniel was presented to the referring veterinarian following a road traffic accident. On emergency assessment, the dog was distressed and tachycardic with extensive superficial wounds to the head and neck, frequent intermittent vocalization, and severe cervical hyperesthesia. The remainder of the physical examination findings were unremarkable. Point-of-care ultrasonography revealed no free fluid in the thorax or abdomen. Results of a minimum emergency clinicopathologic analysis were considered normal. The dog's condition was stabilized with IV fluid therapy and multimodal analgesia, including meloxicam (0.2 mg/kg, IV, q 24 h), acetaminophen (10 mg/kg, IV, q 12 h), methadone (0.5 mg/kg, IV, q 4 h), and a constant rate infusion of ketamine (3 µg/kg/min, IV).

Neurologic examination

Observation

Mental	Alert	X	Depressed		Disoriented		Stupor		Coma		
Posture	Normal	X	Head tilt		Tremor		Falling		Other		
Gait	Normal		Ataxia	X	Pelvic limbs		All 4	X	Circling		
Paresis	Pelvic limbs		Tetra		Hemi	X	Mono				
Other	Low head carriage, left-sided hemiparesis, and pacing when walking (ipsilateral limbs moved synchronously)										

Key: 4 = Exaggerated, clonus; 3 = Exaggerated; 2 = Normal; 1 = Diminished; 0 = None; NE = Not evaluated.

Postural reactions	Left forelimb	Right forelimb	Left hind limb	Right hind limb
Wheelbarrow	NE	NE		
Hopping	NE	NE	NE	NE
Extensor postural thrust			NE	NE
Proprioceptive positioning	1	2	2	2
Hemistand/walk	NE	NE	NE	NE
Placing–tactile	NE	NE		
Placing–visual	NE	NE		

Spinal reflexes	Left forelimb	Right forelimb	Left hind limb	Right hind limb
Quadriceps			2	2
Extensor carpi	2	2		
Flexion	2	2	2	2
Crossed extensor	2	2	2	2
Perineal			2	2

Cranial nerves

	L	R
II, VII–Vision menace	2	2
II, III–Pupils resting	2	2
Stim L	2	2
Stim R	2	2
II–Fundus	2	2
III, IV, VI–Strabismus, resting	0	0
III, IV, VI, VIII–Strabismus, position	NE	NE

	L	R
VIII–Nystagmus, resting	0	0
VIII–Nystagmus, change	NE	NE
V–Sensation	2	2
VII–Facial mm	2	2
V, VII–Palpebral flex	2	2
IX, X–Gag	2	2
XII–Tongue	2	2

Comments

Positional nystagmus and strabismus were not assessed to avoid excessive neck manipulation.

Sensation (Locate and describe any abnormality)

Hyperesthesia	4	Evident on palpation of the cranial cervical region. Voluntary movement of the dog's head and neck elicited frequent vocalization.
Superficial pain	2	
Cutaneous reflex	2	
Deep pain	NE	

What is the problem? Where is the lesion? What are the most probable causes of this problem? What is your plan to establish a diagnosis? Please turn the page.

Assessment

Anatomic diagnosis

Problem	Rule out location
Left-sided hemiparesis	Focal or diffuse C1-T2 spinal cord segments (ipsilateral), brainstem (ipsilateral region), or prosencephalon (contralateral region)
Proprioceptive deficit in left thoracic limb with normal spinal reflexes	Focal or diffuse C1-C5 spinal cord segments (ipsilateral), brainstem (ipsilateral region), or prosencephalon (contralateral region)
Cranial cervical hyperesthesia	Focal or diffuse spinal cord lesion within the C1 through T2 spinal cord segments, cervical soft tissues (muscles or ligaments), articular joints, vertebral bodies, intervertebral disks, spinal nerve roots, or meninges or secondary to thalamic pain

Likely location of 1 lesion

C1-C5 spinal cord segments (left lateralizing lesion)

Etiologic diagnosis—Differential diagnoses for an acute, painful C1-C5 myelopathy following a traumatic event included vertebral fractures, vertebral luxations and subluxations, intervertebral disk extrusion (type 1), or less likely, acute noncompressive nucleus pulposus extrusion (ANNPE) or acute (compressive) hydrated nucleus pulposus extrusion (AHNPE), fibrocartilaginous embolism, and spinal cord contusion. The initial diagnostic plan included survey radiography of the entire vertebral column, thorax, and abdomen to identify traumatic injuries and advanced imaging to allow more accurate detection of osseous abnormalities (ie, CT) or assess the soft tissue structures and spinal cord with more detail (ie, MRI).

Diagnostic test findings—Radiographs were performed by the referring veterinarian prior to referral. In a right lateral radiographic view of the cervical portion of the vertebral column, there was moderate widening of the space between the dorsal arch of the atlas and spinous process of the axis with marked craniodorsal displacement of the axis into the vertebral canal **(Figure 1)**. The ventrodorsal radiographic view of the cervical portion of the vertebral column indicated rotation and sinistrad displacement of the atlas, with resulting malarticulation between the occipital condyles and cranial articular fovea of the atlas. At the referral hospital, the dog was anesthetized and a CT[a] performed which confirmed the radiographic

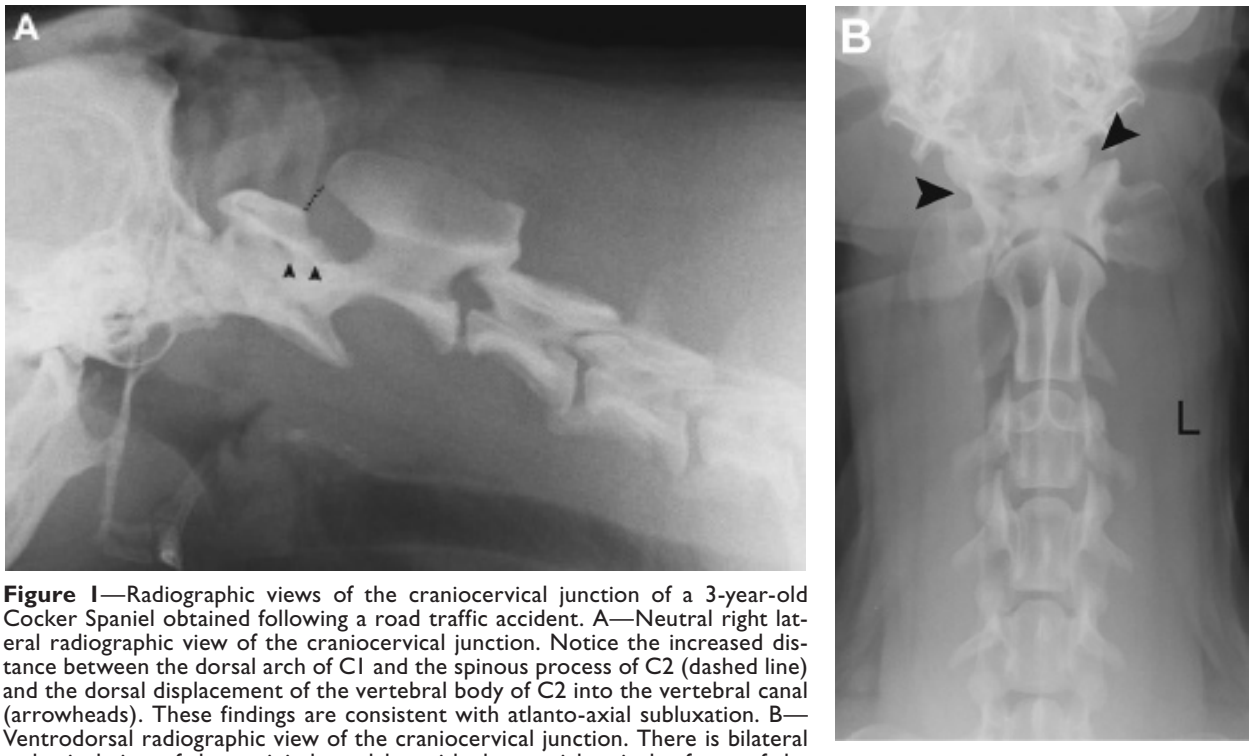

Figure 1—Radiographic views of the craniocervical junction of a 3-year-old Cocker Spaniel obtained following a road traffic accident. A—Neutral right lateral radiographic view of the craniocervical junction. Notice the increased distance between the dorsal arch of C1 and the spinous process of C2 (dashed line) and the dorsal displacement of the vertebral body of C2 into the vertebral canal (arrowheads). These findings are consistent with atlanto-axial subluxation. B—Ventrodorsal radiographic view of the craniocervical junction. There is bilateral malarticulation of the occipital condyles with the cranial articular fovea of the atlas (C1; arrowheads), consistent with an atlanto-occipital luxation.

findings and further revealed a 3-mm-long dens avulsion fragment with associated vertebral sinus compression and fracture of the right epihyoid bone. The diagnostic imaging modalities confirmed a diagnosis of atlanto-occipital (AO) luxation and atlanto-axial (AA) subluxation, with an associated dens avulsion fracture. Subsequent treatment was provided at the referral hospital.

Surgical treatment was recommended to achieve stabilization of the cranial cervical area. However, owing to the presence of extensive and contaminated wounds around the prospective surgical site, medical management was temporarily initiated. A cervical splint made from thermoplastic material,[b] padding material,[c-e] and elastic bandage[f,g] was placed from the rostral portion of the mandible to the manubrium to minimize neck movement. Treatment was continued with fentanyl (2 µg/kg/h, IV as a constant rate infusion), dexmedetomidine (1 µg/kg/h, IV as a constant rate infusion), acetaminophen (10 mg/kg, IV, q 12 h), and cefuroxime (20 mg/kg, IV, q 8 h). Meloxicam administration was discontinued because of gastrointestinal adverse effects. Three days later, the dog remained neurologically stable and was discharged from the hospital. The owners were instructed to administer gabapentin (10 mg/kg, PO, q 8 h for 14 days), acetaminophen with codeine (10 mg/kg and 0.5 mg/kg, respectively, PO, q 12 h for 7 days), and trazodone (50 mg, PO, as needed) and provide strict rest. Topical application of hypochlorous spray and cefalexin (20 mg/kg, PO, q 12 h for 14 days) were prescribed to treat the skin wounds. The dog was reassessed weekly with a repeated neurologic examination and replacement of the cervical splint. One week after presentation to the tertiary care facility, the dog's neurologic status remained stable and the owners reported few episodes of vocalization. Two weeks later, full resolution of the superficial skin wounds was observed. However, the dog had developed bilateral *Malassezia* otitis externa that required topical treatment.[g] At this point, apart from mild left thoracic limb paresis, the dog's neurologic examination findings were apparently normal. Given the dog's excellent response to treatment, conservative management was continued and after 8 weeks, the cervical splint was removed. Four weeks later, the dog's physical and neurologic examination findings were completely normal, and exercise was progressively introduced. Fourteen months after the initial injury, the dog was reported to have resumed a normal lifestyle.

Comments

Traumatic AO luxation and AA instability are infrequently reported as causes of cranial cervical myelopathy in dogs and cats[1–12] and have not been described as concurrent problems in veterinary patients, to our knowledge. Reports[3–12] of traumatic AO luxation are available for 13 dogs and 2 cats, with a history of a road traffic accident in most cases. A wide range of neurologic deficits associated with traumatic AO luxation have been described including ambulatory or nonambulatory tetraparesis, hemiparesis, proprioceptive ataxia, palpable craniocervical asymmetry, and vestibular signs.[3–12] Among 15 reported cases of traumatic AO luxation, successful outcomes were achieved for 12 dogs and 2 cats, of which 10 dogs were treated surgically, and 2 dogs and 2 cats were treated medically. Conservative management of AO luxation has involved closed reduction under anesthesia followed by external immobilization and strict rest for 8 weeks.[9–11] In 1 cat and 1 dog with chronic AO luxation, closed reduction failed and surgery was performed.[3,7] Conversely, surgical stabilization failed in another dog with AO luxation and subsequent conservative management resulted in the dog's full recovery.[6] Reported surgical approaches for AO luxation include decompressive dorsal laminectomy of the atlas and wiring of the wing of the atlas to the base of the occipital condyle,[5] AO arthrodesis with a single cortical lag screw,[6] ventral fixation with cortical screws in combination with polymethyl methacrylate stabilization,[8] foramen magnum decompression,[7] and an external ligature technique.[4]

In contrast to congenital AA instability, traumatic AA instability can occur at any age in any breed of dog.[1,2] However, treatment options remain the same for both conditions. Conservative management involves placing a cervical splint to immobilize the neck, provision of analgesia, and strict rest for 6 to 8 weeks. With this method, AA stability is achieved through the formation of periarticular fibrosis and the reported rate of successful outcomes is 62.5% (10/16 dogs).[1] Although medical management has been typically reserved for those patients with cervical hyperesthesia or mild neurologic deficits, successful outcomes with medical management have also been achieved for tetraplegic and nonambulatory tetraparetic patients; early intervention (< 30 days from onset of clinical signs) correlates with a better prognosis.[1,13] Similar to the case described in the present report, dermatologic complications (eg, moist dermatitis, ulceration, and otitis externa) associated with external immobilization are common. Furthermore, ongoing monitoring of patients following removal of the cervical splint is essential because of a risk of AA instability relapse.[1]

Currently, surgical stabilization is considered the preferred management option for AA instability, with successful outcome rates of approximately 65% to 88% depending on the surgical technique used.[2,13,14] Dorsal and ventral surgical approaches have been described, of which ventral techniques are associated with better outcomes.[14] However, surgery-related mortality rates of approximately 10% and the potential for postoperative complications (eg, worsened neurologic grade, aspiration pneumonia, respiratory failure, and implant complications) demand careful consideration.[2,13,14]

When traumatic AO luxation or AA subluxation is considered likely, careful management of patients is recommended to prevent further spinal cord damage and neurologic deterioration. A focused neurologic examination should be performed to rapidly localize and determine the extent of the lesion, while avoiding tests that involve head or neck manipulation (eg, assessment of strabismus). Patients should subsequently be immobilized (ie, on a spinal board) until vertebral column fractures or instabilities can be excluded. Approximately 75% of vertebral column fractures or subluxations are detectable with plain radiography,[15] a cost-effective imaging modality that is readily available in clinical practice. However, CT is recommended in most cases to definitively rule out vertebral column fractures or instability.[16] Following identification of a craniocervical instability, a cervical splint should be placed immediately, pending further management of the patient.

Remarkably, despite concurrent AO luxation and AA instability, the dog of the present report had minimal neurologic deficits at the time of presentation. Thus, it is important not to underestimate the severity of injury on the basis of neurologic examination findings. For this dog, prompt diagnosis of concurrent AO luxation and AA instability and initiation of external immobilization were critical not only in avoiding potential progression of neurologic deficits, but also in facilitating pain management, and thus promoting a successful outcome. Although surgical treatment was initially considered, it was never warranted because of the dog's rapid recovery. Given the lack of available reports regarding outcomes for veterinary patients with concurrent AO luxation and AA instability, a guarded prognosis for affected animals should be discussed with owners. Referral for advanced diagnostic imaging and surgical stabilization should be offered, but medical management may be a viable option when referral is not practical or the neurologic examination findings improve in a short period.

Footnotes

a. Siemens SOMATOM Definition AS, Siemens AG, Munich, Germany.
b. Vet-Lite thermoplastic bandage, Kruuse, Denmark.
c. Soffban Plus synthetic padding bandages, BSN Medical, Hull, UK.
d. K-Band conforming bandage, URGO Medical, Loughborough, UK.
e. Allevyn foam, Smith & Nephew, Watford, UK.
f. Wrapz, Millpledge Veterinary, Retford, UK.
g. Tensoplast, BSN Medical, Hull, UK.
h. Osurnia, Dechra Veterinary Products, Shrewsbury, UK.

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