Acta Scientiae Veterinariae, 2023. 51(Suppl 1): 926.

CASE REPORT
Pub. 926

ISSN 1679-9216

Klippel-Feil Syndrome (Type I) and Disc Cervical Extrusion in a Dog

Emerson Gonçalves Martins de Siqueira[1], Fernanda Catacci Guimarães[3], Sheila Canevese Rahal[1], Luigi Milanez Avila Dias Maciel[1], Vânia Maria de Vasconcelos Machado[1], Rodrigo Bazan[2], Pedro Tadao Hamamoto Filho[2] & Rebeca Bastos Abibe[1]

ABSTRACT

***Background*:** Klippel-Feil Syndrome (KFS) is a rare diagnosed condition in human and animals. They are usually asymptomatic and considered a clinical finding after image exam due to another neurological sign. This syndrome can be classified in Type I, Type II or Type III. The immobile neck may cause a biomechanical change in the spine motion and predispose disc herniation. This case aims to report a case of a dog with diagnosed KFS with disc extrusion, its treatment and follow up.

***Case*:** A 8-year-old entire male Dachshund was referred for evaluation because of a history of chronic cervical kyphosis and low head carriage, and a 7-day history of acute onset of non-ambulatory spastic tetraparesis and neck pain without improvement after clinical treatment with non-steroidal anti-inflammatory and analgesic. Blood and white cell count were within the normal range, as vital parameters. Cranial nerves were considered normal and no brain disorder was observed during physical examination, only aggressive behavior after management related to pain. Hyperreflexia and hypertonia were observed in all 4 limbs, with cervical painful cervical flexion and turning. Plain radiographs of the cervical spine revealed fusion of the vertebral bodies of C2 and C3, and calcification of the intervertebral disc at C5-C6, with mild narrowing of the disc space. MRI revealed fusion between C2-C3 with an absence of the intervertebral disc, and changes in the signal intensity of the spinal cord were not identified at the malformation site. In the ventral aspect of the spinal canal dorsal to C5-C6 disc space, there was T2 hypointense material consistent with herniated intervertebral disc material, causing extradural spinal cord compression. The diagnosis was Klippel-Feil syndrome (Type I) at C2-C3 and disc extrusion at C5-C6. A ventral slot decompression surgery was performed between C5-C6, the intervertebral space was identified based on palpation of the transverse process of C6. On the day after the surgery the patient displayed a neurological improvement with ambulatory spastic tetraparesis, and on the 5th day the dog was able to get up and walk without ataxia and neck pain. At the final evaluation, 1.6 years after the surgery, the dog was neurologically normal.

***Discussion*:** Due to its common undiagnosed frequency in veterinary medicine, this case report presents a diagnosed Klippel-Feil syndrome (KFS) with disc extrusion in a dog. Corroborating with usual findings in this syndrome, this patient presented short neck and limited neck range of motion in flexion and extension. The low posterior hairline was mild. KFS may be find occurring with intervertebral disc disease in consequence of the change in the spine's range of motion. Other abnormalities have been associated in human KFS, such as scoliosis, rib deformity, deafness and systemic disorders as renal and cardiovascular. The patient in this case report presented any systemic injury possible to relate with the KFS. The gold standard diagnostic method is magnetic resonance image (MRI), but a gross evaluation can be made in the simple x-ray. Surgical treatment is not necessary when KFS is asymptomatic. Disc extrusion is associated to possible stress on normal intervertebral disc due to decreased mobility in the fused cervical segment. Ventral slot was performed in the C5-C6 disc extrusion to spinal cord decompression, the location corroborates with usual site of intervertebral disc disease. During the follow up (> 1 year), the patient maintained itself neurologically normal. This case report raises the importance to identify KFS in veterinary medicine, which may be being under-reported and its possibility to bias degenerative disease in the intervertebral disc.

Keywords: vertebrae fusion, congenital deformities, canine, KFS, IDD, ventral slot.

DOI: 10.22456/1679-9216.121952

Received: 30 July 2023 Accepted: 24 November 2023 Published: 26 December 2023

[1]Department of Veterinary Surgery and Animal Reproduction, School of Veterinary and Animal Science & [2]Department of Neurology, Psychology and Psychiatry, Botucatu Medical School, São Paulo State University (UNESP), Campus Botucatu, SP, Brazil. [3]Department of Surgical and Radiological Sciences, School of Veterinary Medicine, University of California, Davis (UCD), CA, USA. CORRESPONDENCE: R.B. Abibe [rebeca.abibe@unesp.br]. Departament of Veterinary Surgery and Animal Reproduction - UNESP. Distrito de Rubião Júnior s/n. CEP 18618970 Botucatu, SP, Brazil.

INTRODUCTION

Klippel-Feil Syndrome (KFS) is a rare congenital deformity that is characterized by fusion of two cervical vertebrae [3,6,10] and it has been rarely described in dogs [3]. There is a broad range of associated conditions, as congenital scoliosis, scapula deformity, rib anomalies and aplasia of the atlas [5,8].

This syndrome is often asymptomatic and expressed by a triad presenting short neck, limited cervical range of motion and low posterior hairline [9]. The diagnosis is commonly related with a traumatic event or incidental imaging find [7,9].

KFS is classified based on the segments of the fused cervical vertebrae. Type I is defined as a single congenitally fused cervical segment, Type II as multiple non-contiguous congenitally fused segments and Type III with multiple continuous congenitally fused cervical segments. [6,9].

This paper aims to describe the occurrence of a KFS Type I in a dog associated with cervical IDD, its treatment and follow up.

CASE

A 8-year-old entire male Dachshund, weighing 11.5 kg, was referred for evaluation because of a history of chronic cervical kyphosis and low head carriage, and a 7-day history of acute onset of non-ambulatory spastic tetraparesis and neck pain. The dog had received medical management with analgesic and non-steroidal anti-inflammatory drugs but showed no neurological improvement. According to the owner, kyphosis was noticed since the dog was born.

On physical examination, the dog was on lateral recumbency with normal mental status (bright and alert) but showed aggressive behavior probably related to pain. The patient appeared to have a short neck. The body condition score was 3 on a 5-point scale system. The rectal temperature, respiratory rate, and heart rate were within the normal range. On neurological examination, the patient presented a non-ambulatory spastic tetraparesis and absence of proprioception. Cranial nerves were considered normal and no intention tremors, head tilt nor head turn were observed. Regarding spinal reflexes, hypertonia and hyperreflexia were observed in all 4 limbs. Limitation and cervical pain in flexion as well as turning the neck towards the right and left sides were present. Complete blood count and biochemical analysis were within the normal ranges. Urine was collected by catheterization and urinalysis showed specific gravity > 1.050, pH = 5.5, 4+ blood, hyaline casts, bacteria, and transitional epithelial cells.

Under heavy sedation, plain lateral and ventrodorsal radiographs of the cervical spine and thorax were taken. Plain radiographs of the cervical spine revealed fusion of the vertebral bodies of C2 and C3, malposition of the C2, reduced length of the segment C2-C3 because of fusion and inclination of C3 when compared to C2. Calcification of the intervertebral disc at C5-C6, with mild narrowing of the disc space (Figure 1). No abnormalities were found on thoracic radiographs. Based on radiographic findings, the Klippel--Feil Syndrome (Type I) at C2-C3 and disc extrusion at C5-C6 were suspected. Due to the limitations of radiography for identifying clinically relevant sites of intervertebral disc disease/spinal cord compression and the need for cross-sectional imaging/myelography to assess cord compression, magnetic resonance imaging (MRI) was recommended.

The dog was submitted to general anesthesia using propofol[1] [5.2 mg/kg, IV] to induction, and maintenance with isoflurane in 100% oxygen after intratracheal intubation. MRI of the cervical spine was performed with a 0.25 Tesla Scanner[2]. Sagittal and transverse T1-weighted (T1W), T2-weighted (T2W) and STIR-weighted sequences without contrast were acquired. MRI revealed fusion between C2-C3 with an absence of the intervertebral disc, and changes in the signal intensity of the spinal cord were not identified at the malformation site (Figure 2 A). At C5-6, the intervertebral disc had reduced T2 signal intensity with a central nuclear cleft, consistent with disc degeneration. In the ventral aspect of the spinal canal dorsal to C5-C6 disc space, there was T2 hypointense material consistent with herniated intervertebral disc material, causing extra-dural spinal cord compression [Figure 2 B & C]. On the basis of MRI findings, the diagnosis was Klippel-Feil Syndrome (Type I) at C2-C3 and disc extrusion at C5-C6.

A ventral slot decompression surgery was performed. After premedication with methadone[3] [0.3 mg/kg, IM] and acepromazine[4] [0.03 mg/kg, IM], anesthesia was induced with propofol[1] [3 mg/kg, IV], followed by endotracheal intubation, and maintained with isoflurane. The dog was positioned in dorsal recumbency with head and neck maintained in mild extension. A towel was placed under the neck. The

region from mandible level to manubrium was prepared aseptically for surgery. A ventral approach to the cervical spine was done. The intervertebral space between C5-C6 was identified based on palpation of the transverse process of C6. The bony slot included approximately one-third of both the width and length of the C5 and C6 vertebrae. Amoxicillin-clavulanate[5] [20 mg/kg, PO, q 8 h] was prescribed prior to the surgical procedure and 14 days postoperatively. Immediately after surgery, gabapentin[6] [initiated at 5 mg/kg PO q 8 h with dosing frequency reduction every 20 days], and prednisone[7] [at 0.5 mg/kg PO q 24 h for 3 days, followed by 0.25 mg/kg q 24 h for 3 days].

About 24 h following surgery, the dog showed improvement in neurological signs, which displayed ambulatory spastic tetraparesis. On the 5th day after surgery, the dog was able to get up and walk. Clinical signs of proprioceptive ataxia were not seen. No pain was elicited upon flexion and extension as well as turning the neck. The neck was short and limited in flexion and extension. At the final evaluation, 1.6 years after the surgery, the dog was neurologically normal.

DISCUSSION

Klippel-Feil syndrome is described in human patients as congenital synostosis of some or all cervical vertebrae [4,5]. The prevalence of Klippel-Feil syndrome is no totally defined, but 1:40,000-42,000 births have been estimated to present the lesion [10]. However, a CT study detected a higher prevalence (1 in 172) [5]. On the other hand, a few cases of Klippel--Feil Syndrome have been described in dogs [1,3]. The etiology of the disease in humans is not well known, but some cases have been related to gene mutation

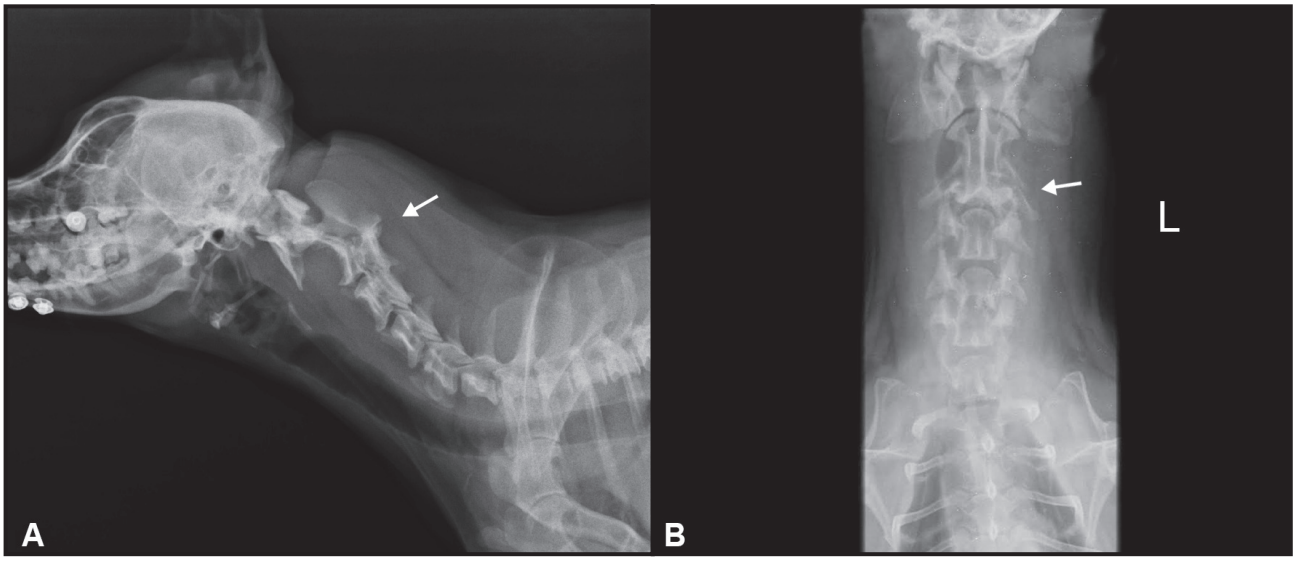

Figure 1. Plain lateral (A) and ventrodorsal (B) radiographs of the cervical spine. A- Observe the fusion of the vertebral bodies of C2 and C3 (arrow), the dorsal inclination of C3 when compared to C2, and the calcification of the intervertebral disc at C5-6, with mild narrowing of the disc space. B- C2C3 vertebral fusion (arrow) with reduced length of the segment C2-C3.

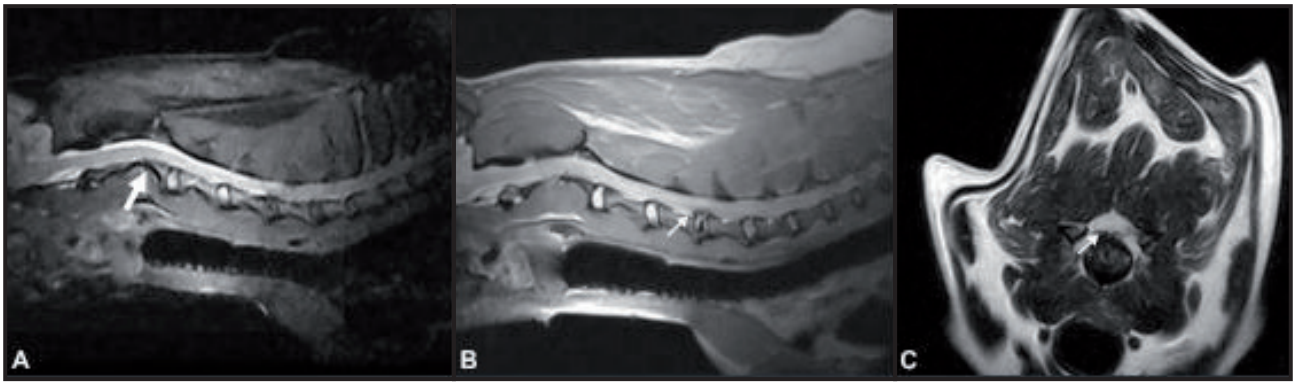

Figure 2. MRI images of the cervical spine. A- Fusion between C2-C3 with an absence of the intervertebral disc, and no visual signal intensity changes in the spinal cord at malformation site (arrow) are visualized on the sagittal STIR-weighted image. B- At C5-C6, the intervertebral disc has reduced T2 signal intensity with a central nuclear cleft, consistent with disc degeneration. C- In the ventral aspect of the spinal canal dorsal to C5-6 disc space, there is T2 hypointense material consistent with herniated intervertebral disc material, causing extradural spinal cord compression (arrow).

[4,10]. Mutations were not identified in MEOX1, PAX1, and FGFR3 genes, which were evaluated in a Golden Retriever dog with KFS-like syndrome [2].

Based on the radiographic classification, 3 types of Klippel-Feil syndrome have been described in human patients: Type I- Single fused cervical segment; Type II- Multiple noncontiguous fused segments; and Type II - Multiple contiguous cervical fusions [6,9]. The present case was classified as Type I due to radiographic features with C2-C3 fusion. A computed tomography (CT) study in asymptomatic human patients observed that C2-C3 and C5-C6 were the most frequent fused levels [5]. However, the cases described in dogs have shown heterogeneity of vertebral malformations [1-5,7-9].

Less than 50% of human patients may present the triad of short neck, low posterior hairline, and limited neck range of motion [4,10]. The dog here reported also presented a short neck and limited neck range of motion in flexion and extension. The clinical severity in humans is variable according to bony anomalies [4,10]. Pain and neurologic symptoms, and decreased rotation, flexion, and extension of the neck are symptoms that may be present [1]. However, in some cases, the cervical synostosis may be asymptomatic and can be incidentally detected on radiographs [4,10].

The neurologic deficits showed by the dog in the present case were not related to the cervical malformation, but extruded intervertebral disc as detected on MRI study. In 4 dogs (3 Dachshunds and 1 Pekingese) presenting cervical vertebral fusion detected radiographically, the signs of spinal cord compression were also related to extruded intervertebral disc at another site, which was associated to possible stress on normal intervertebral discs due to decreased mobility in the fused cervical segment [1]. Since our patient was a Dachshund (i.e. chondrodystrophic breed) which is at least as likely to be the underlying cause for intervertebral disc disease at C5-6 as the C2-3 fusion changing biomechanics. The greater risk of spondylotic myelopathy has also been observed in human patients with Klippel-Feil syndrome; however, according to the authors, the influence of increased biomechanical of segments next to a fused vertebra in lesion development must be proved [7].

Concurrent spinal abnormalities, muscular and neurological abnormalities, and other types of abnormalities have been associated in human patients with Klippel-Feil syndrome, such as scoliosis, rib deformity, deafness, and vascular and cardiovascular abnormalities, renal abnormalities, among others [4,10]. The abnormality of the scapula was verified in a Golden Retriever dog with KFS [2]. No other abnormality was observed in the case here reported.

Findings in the dog of the present report highlighted the importance to identify KFS, which may be being under-reported, and the probable susceptibility to the development of degenerative changes of adjacent vertebral segments in dogs with Klippel-Feil Syndrome.

MANUFACTURERS

[1]União Química Farmacêutica Nacional Ltda. São Paulo, SP, Brazil.
[2]Esaote s.p.a. Genoa, Italy.
[3]Cristália Produtos Químicos Farmacêuticos Ltda. Itapira, SP, Brazil.
[4]Syntec do Brasil. Barueri, SP, Brazil.
[5]Zoetis Brasil. Paulínia, SP, Brazil.
[6]EMS Pharma Farmacêutica. Hortolândia, SP, Brazil.
[7]MSD Saúde Animal. São Paulo, SP, Brazil.

Declaration of interest. The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

REFERENCES

1 Bagley R.S., Forrest L.J., Cauzinille L., Hopkins A. L. & Kornegay J.N. 1993. Cervical vertebral fusion and concurrent intervertebral disc extrusion in four dogs. *Veterinary Radiology & Ultrasound*. 34(5): 336-339.

2 Bertolini G., Trotta M., & Caldin M. 2015. A skeletal disorder in a dog resembling the Klippel–Feil Syndrome with Sprengel's Deformity in humans. *Journal of Small Animal Practice*. 56(3): 213-217. DOI: 10.1111/jsap.12268.

3 Fernandes R., Fitzpatrick N., Rusbridge C., Rose J. & Driver C.J. 2019. Cervical vertebral malformations in 9 dogs: radiological findings, treatment options and outcomes. *Irish Veterinary Journal*. 72(1): 1-13. DOI: 10.1186/s13620-019-0141-9.

4 Frikha R. 2020. Klippel-Feil syndrome: a review of the literature. *Clinical Dysmorphology*. 29(1): 35-37. DOI: 10.1097/MCD.0000000000000301.

5 Gruber J., Saleh A., Bakhsh W., Rubery P.T. & Mesfin A. 2018. The prevalence of Klippel-Feil syndrome: a computed tomography–based analysis of 2,917 patients. *Spine Deformity*. 6(4): 448-453. DOI: 10.1016/j.jspd.2017.12.002.

6 **Gunderson C.H., Greenspan R.H., Glaser G.H. & Lubs H.A. 1967.** The Klippel-Feil syndrome: genetic and clinical revaluation of cervical fusion. *Medicine*. 46(6): 491-512. DOI: 10.1097/00005792-196711000-00003

7 **Nouri A., Tetreault L., Zamorano J.J., Mohanty C.B. & Fehlings M.G. 2015.** Prevalence of Klippel-Feil syndrome in a surgical series of patients with cervical spondylotic myelopathy: analysis of the prospective, multicenter *AOSpine North America Study*. *Global Spine Journal*. 5(4): 294-299. DOI: 10.1055/s-0035-1546817.

8 **Sabuncuoğlu H., Özdoğan S., Karadağ D. & Timurkaynak E. 2011.** Congenital hypoplasia of the posterior arch of the atlas: Case report and extensive review of the literature. *Turkish Neurosurgery*. 21(1): 97-103. PMID: 21294100

9 **Samartzis D., Herman J., Lubicky J.P. & Shen F.H. 2006.** Classification of congenitally fused cervical patterns in Klippel-Feil patients: epidemiology and role in the development of cervical spine-related symptoms. *Spine*. 31(21): E798-E804. DOI: 10.1097/01.brs.0000239222.36505.46.

10 **Tracy M.R., Dormans J.P. & Kusumi K. 2004.** Klippel-Feil syndrome: clinical features and current understanding of aetiology. *Clinical Orthopaedics and Related Research*. 424: 183-190. DOI: 10.1097/01.blo.0000130267.49895.20